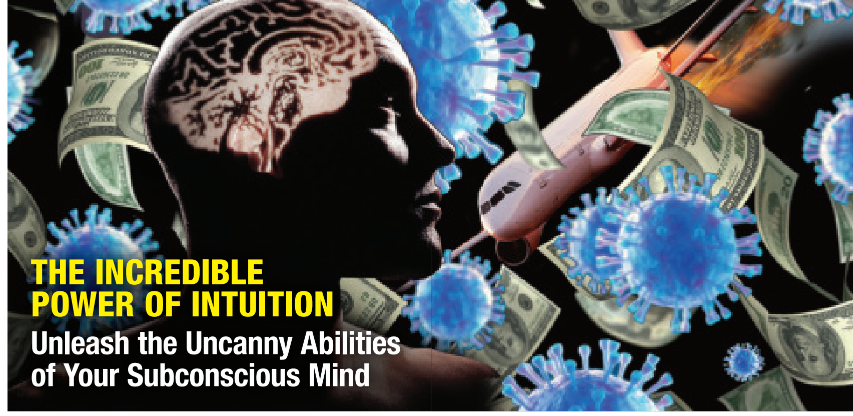
iD

IDEAS&DISCOVERIES



THE INCREDIBLE POWER OF INTUITION

Unleash the Uncanny Abilities of Your Subconscious Mind

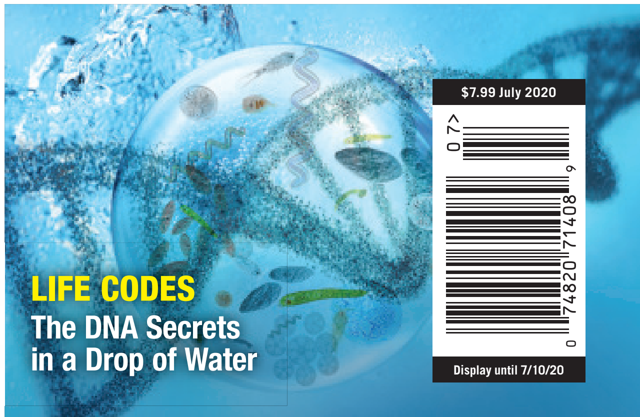
COLD CASES

THE UNSOLVED MURDERS OF HISTORY

The Plight of the **ROVING GIANTS**

APOLLO 11

The Epic Mission That Put Men on the Moon



LIFE CODES

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Actual size is approximately 20 mm

Deluxe Coin Holder

NEW HOARD OF ANCIENT SILVER COINS OF CHRIST DISCOVERED!

Own A 700-Year-old Silver Portrait of Jesus Christ

When we heard the news, our jaws hit the floor. A massive hoard of ancient silver coins, struck in Constantinople during the last dynasty of the Byzantine Empire, had just been discovered. And the coins depicted a portrait of Jesus Christ!

We jumped to secure as many of the best coins as possible. But to get the best, we needed an expert: famous numismatist and best-selling author Jeff Garrett. When the Smithsonian® needs help with their National Numismatic Collection, they call Jeff Garrett. So we did, too.

Garrett was able to sift through the hoard and hand-pick the finest pieces featuring the clearest images of Christ for our customers. We sent these coins to respected third-party grading company Numismatic Guaranty Corporation (NGC) for grading and certification.

These coins represent some of the finest, brightest pieces from that historic hoard!

What Began with Constantine Ends With Andronicus II

During the reign of Constantine, worship of the sun god Sol Invictus was merged with the worship of Christ, as the emperor believed them to be one and the same. Constantine's coins presented an image of the deity, helping to spread Christianity throughout the empire.

The Byzantine Empire had officially become the world's first Christian Empire. But then came Andronicus II.

Struck During the Decline of the Byzantine Empire

On the reverse of these incredible coins, Christ stands alone. But the obverse displays two figures: co-emperors Andronicus II and his son Michael IX.

The reign of Andronicus II (1282–1328) marked the beginning of the end for the Byzantine Empire. The Ottoman Turks advanced into Asia Minor, and though Andronicus paid mercenaries to repel the invaders (perhaps using these very coins?), these hired soldiers eventually turned on their employers, further sending the empire into chaos.

An Incredible Find

Struck between 1304 and 1320, these silver coins of Andronicus II and Michael IX are relics of the First Christian Empire as it neared its end.

To quote Jeff Garrett, "To find a modern hoard of ancient coins surviving with this quality is nothing short of incredible." Not only are these coins 700 years old, but they were struck in lustrous silver—an unusual metal for coins of the time, which tended to be struck in gold (and thus were quickly melted as power changed hands).

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You talk, we listen! Here's what you had to say about previous issues of iD. Thanks for your feedback and suggestions. Keep 'em coming.

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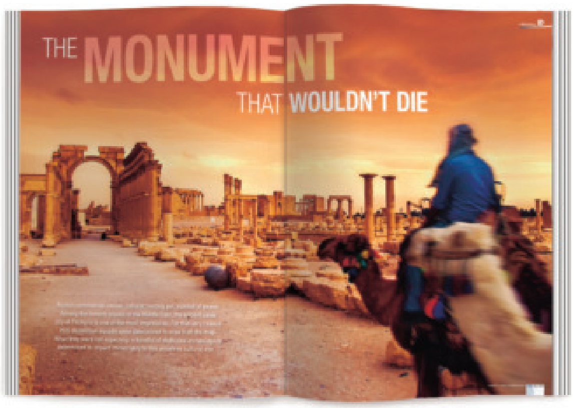

THE MONUMENT THAT WOULDN'T DIE

A MONUMENTAL EFFORT

The May issue was packed with great stories, but the one about "The Monument That Wouldn't Die" really spoke to me. It's so heartbreaking that in addition to all of the other tragedies that have befallen the Syrian people, even their heritage has been maliciously targeted for destruction. A true tale of redemption rising from the ashes of destroyed cities is surely a balm to the spirit, and there are still signs of the communities' ability to recover and regrow once the violence and oppression finally, hopefully, come to an end.

Stacy Richards, Ringwood, NJ

We too were deeply touched by the sacrifice of the volunteers, and especially the martyrdom of Professor Khaled al-Asaad, who endured torture and laid down his life for the preservation of history and culture. He made the ultimate sacrifice, and his legacy will live on in the history he saved and the inspiration he gave not only to the Syrian people but people everywhere who appreciate his selfless spirit of salvation. And kudos to Roger Michel and his team at the Institute of Digital Archeology who made it possible for the monuments and artifacts to have an eternal digital life after their physical destruction.

HEALING THE DESERT

How amazing is that technique developed by the farmer Tony Rinaudo from the May issue's Photo & Story! He is actually reversing desertification with the most minimal of resources. It's an astounding feat: Areas that were once dry and lifeless are greening up again. It really underscores the central message of the issue, that hope springs eternal. Sometimes in nature what's needed for rejuvenation and growth is still there somewhere beneath the surface of perception, waiting for conditions to become conducive. Hats off to Tony, for figuring out such a blessedly effective way to breathe life into wastelands and improve lives.

Howard Eldridge, Lexington, KY

The farmer-managed natural regeneration technique is indeed a blessing for the areas Tony Rinaudo has worked to pull back from the stranglehold of desert conditions. His ability to study such a daunting problem and develop an elegant solution that can easily be implemented is a natural resource in itself.

iD UPDATE: CLIMATE CHANGE

Soon after the May issue went to press, a news report came out about the rate at which Arctic sea ice is disappearing. As increasing temperatures cause permafrost in the northern latitudes to thaw, the previously frozen soil releases a huge amount of sequestered greenhouse gas, which then speeds up the rate at which the planet warms. And now researchers are realizing that the amount of gas released by ice masses is more than they'd thought: In a process called "abrupt thaw," the warming of small areas of frozen ground leads to the exposure of large ice veins. Although this will likely apply to just 5% of permafrost in the Arctic, it could be enough to nearly double the contribution of melting permafrost to the planet's warming. Currently the pace of warming in the Arctic is about twice the global average.

In other news, researchers from the University of Hawaii at Manoa are sounding an alarm: The world's coral reefs may be all but gone by the year 2100. And water that is ever warmer and more acidic is expected to destroy as much as 90% of all existing coral reefs in the next 20 years. These dire predictions are all the more devastating because coral reefs are the living scaffolding of so many marine ecosystems.

Healthy coral

Bleached coral

Letters to the editor may be edited for clarity and length.

PHOTOS: Vincent Pommeyrol/Getty; Federica Grassi/Getty.

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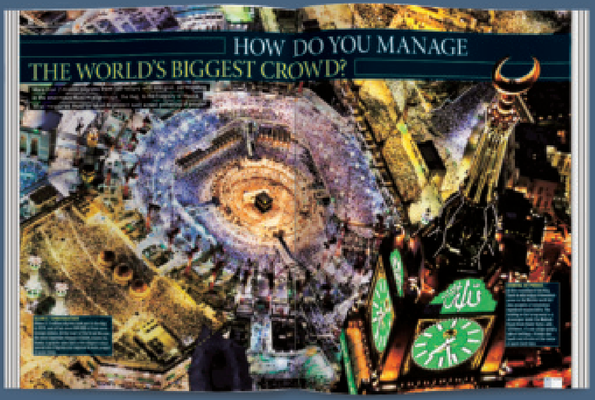
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> “An investment in knowledge pays the best interest.”
>
> —*Benjamin Franklin*

COVER STORY
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There’s a part of us all that knows what to do in sticky situations, even when the part of us that’s supposed to be at the helm comes up short. **PAGE 28**

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WHO WAS THE REAL
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To our readers:

Journeys are set in motion by all manner of motivators. Whether it’s a pilgrimage of devotion made by the faithful, or a raindrop being whisked around the globe in a cloud before plunging earthward, or even humans leaving the Earth entirely and walking on the surface of a heavenly body, setting out from the familiar into parts unknown in pursuit of fulfillment is an inextricable part of the life of humans and the other occupants of the planet. In the figurative sense, one might also move from a state of jeopardy toward security, or from a state of ignorance to revelation. Movement has always been a hallmark of our dynamic universe.

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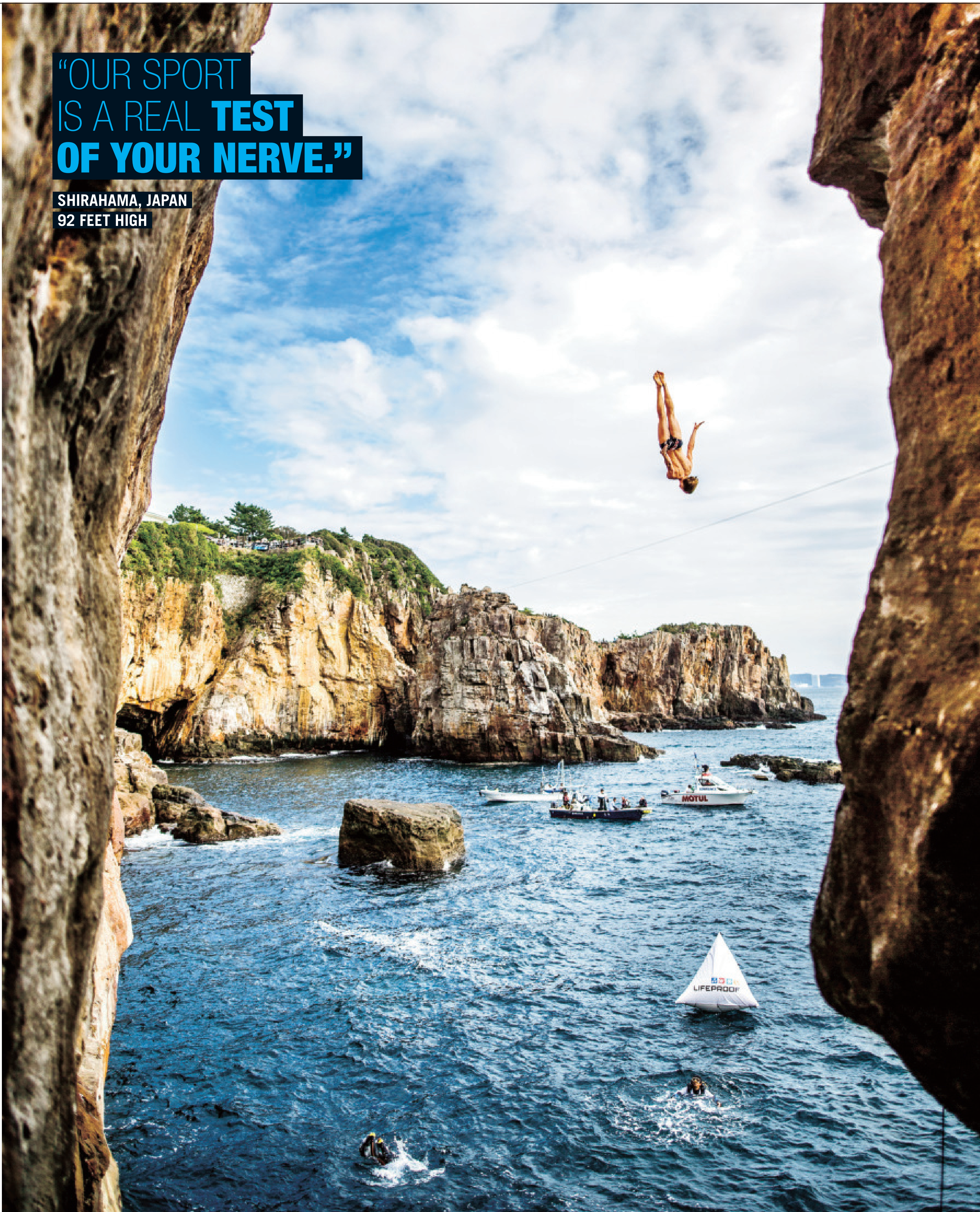
Next issue on stands
July 10

A photo and its story

TAKING THE PLUNGE

Gary Hunt accelerates from 0 to 50 miles per hour in 2.5 seconds—wearing nothing but a Speedo. No one performs better in this incredibly dangerous sport than the British cliff diver, but he still has to overcome his demons before every dive…

“OUR SPORT IS A REAL **TEST OF YOUR NERVE.”**


SHIRAHAMA, JAPAN
92 FEET HIGH

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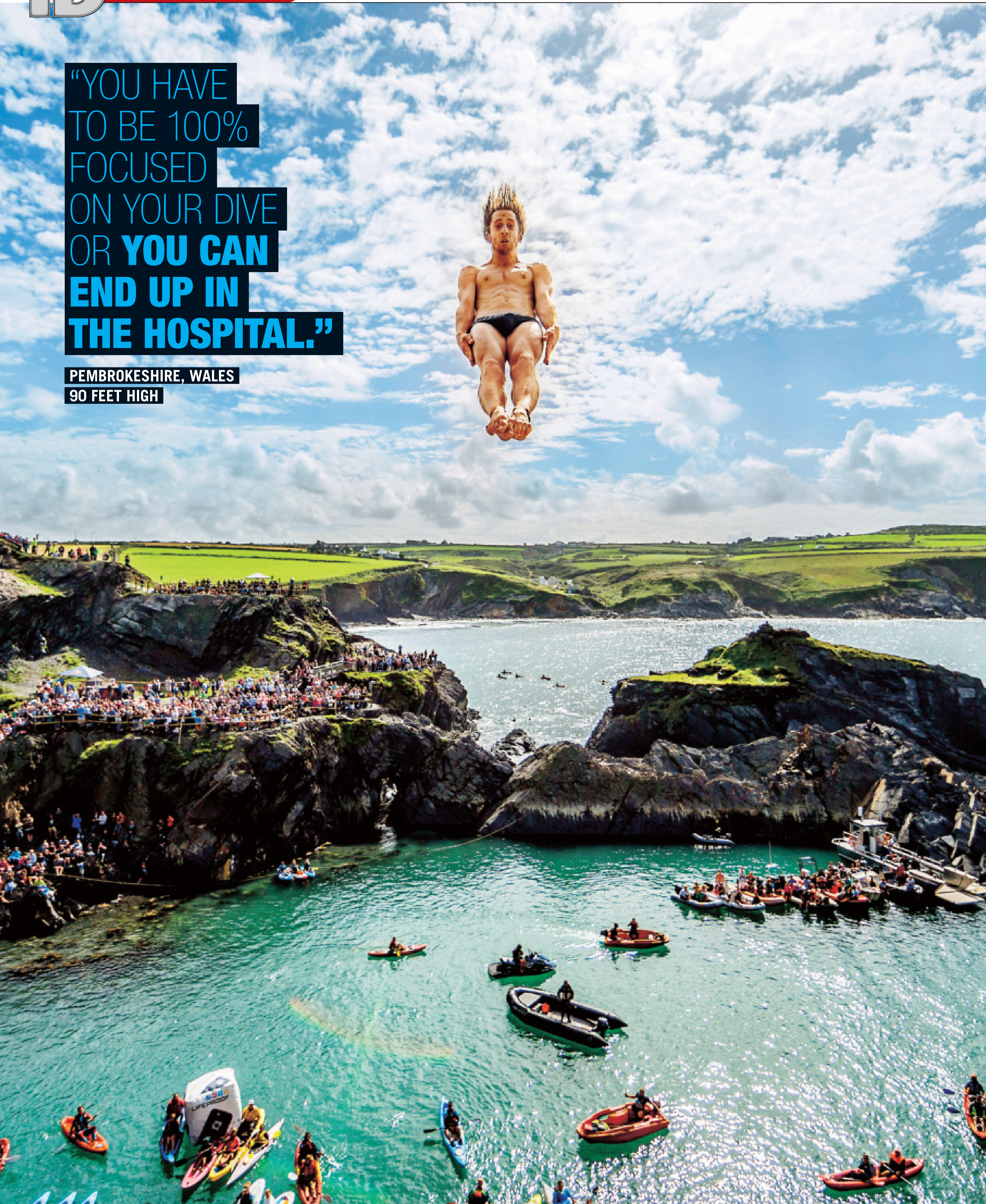


> “YOU HAVE TO BE 100% FOCUSED ON YOUR DIVE OR **YOU CAN END UP IN THE HOSPITAL.”**

PEMBROKESHIRE, WALES
90 FEET HIGH

The force of entry when falling from an extreme height is tremendous: Dropped from 60 feet, for example, a melon or even a granite slab will shatter into a thousand pieces. If a diver's arms aren't close enough to his sides, the force can dislocate his shoulder or fracture his collarbone. Divers entering the water chest-first will have the air knocked out of their lungs and can become unconscious and sink like a stone. If they stretch out their chin, they can risk biting off the end of their tongue. Outstretched fingers can break like matchsticks. And landing on your back can mean not being able to stand or walk again. Gary Hunt is well aware of all this as he stands at the top of a 90-foot-high cliff and looks down. But it's not the risk of bodily harm that worries him—he just has an uneasy feeling that can sometimes border on panic. "When I'm standing on a height and there's no water down below me, it scares the life out of me," he says.

GARY HUNT

AGE: 35

HEIGHT: 5'9"

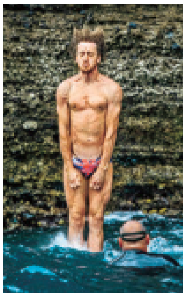
WEIGHT: 150 pounds

CAREER: No cliff diver has been more successful than Gary Hunt since he turned professional in 2009. He has placed in every relevant competition and won the Red Bull Cliff Diving World Series in 8 of the last 10 years.

Cliff diving champion Gary Hunt suffers from acrophobia—the fear of heights. "Those moments before the dive are definitely the scariest," says the 35-year-old. "But once I get to the platform, I've already made the decision to jump—and I have never turned back, although I have had to step back from the edge a couple of times when I could not stop my legs from shaking."

His trick: Hunt isn't just staring at the water's surface 90 feet below. "I'm used to judging the height and seeing how many somersaults and twists I can do from that height," he says. That explains how he's able to overcome his fear of heights as long as there's water down below. "I can't help but imagine how it would feel to somersault and jump off. So if there's no water below me, it frightens me. I'm afraid that something inside me will make me jump." And to provide an even more interesting experience for the spectators, he has introduced a running takeoff, which also makes things considerably harder. "If I get a bad takeoff running, it's very hard to enter the dive." Nonetheless, his takeoff is just one more thing that has made him famous.

Upon entry the body is subjected to intense forces. While Hunt's lower body is experiencing the full braking power of the water, his upper body is essentially still falling, exerting powerful downward pressure and compressing his knees as well as the vertebrae in his spine. The force can be as high as 5 g—five times his body weight. So even a perfect dive can hurt. "The impact is always very, very powerful and very, very violent," he says. "But we do know what we're doing, and that makes it less risky than it looks."



SÃO MIGUEL, AZORES
89 FEET HIGH

ABSOLUTE BODY CONTROL

Takeoff, dive, entry: The whole thing takes only three seconds but requires many years of training. The entry is really the decisive part, says Gary Hunt: "If it's not completely right, the water will break you apart." The lesson: Enter the water as vertically as possible with the whole body aligned.

PHOTOS: Red Bull Content Pool.

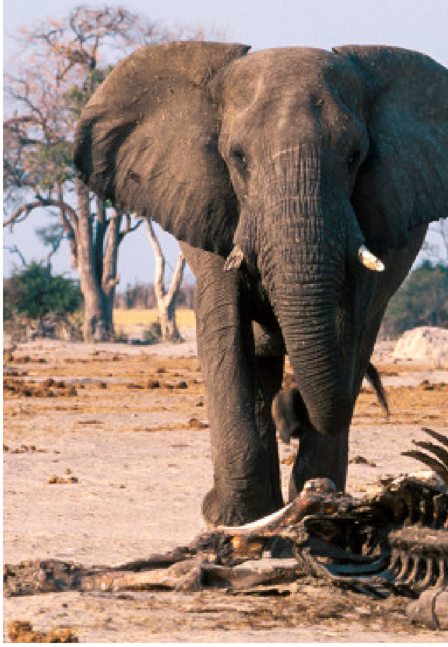
THE PLIGHT OF TH

They are the largest land animals on the planet, and yet there are giants among them, too. But the bigger they are,
All too often these intelligent, sensitive creatures are killed by humans. But there is hope on the horizon, perhaps

IE ROVING GIANTS

the harder they fall. The elephants of Africa face an enormous challenge that threatens their continued existence: even for the particularly vulnerable ones known as the “great tuskers”—the last true giants to walk the earth…

FRAGILE FAMILY
The bond between elephant family members and friends is very strong, and some of these bonds are lifelong. When poachers kill a member of an elephant family, the rest of them mourn. If the matriarch is killed, the family breaks apart. Mothers mourn dead calves, and all the members of the herd grieve with her, often gently touching the carcass with their trunk and feet.



AN ELEPHANT NEVER FORGETS
Some elephants remain near or return to sites where a close friend or family member passed away.

TIGHT BOND
Elephants live in small family groups headed by a mature cow. They generally walk in a single file while on the move in search of food and water. Sometimes calves use their trunk to hold onto their mother's tail to keep up with the group. Cows tend to look out for one another's calves and will often keep calves between them as they move to safeguard the young. Most young bulls live in herds of bachelors, although some lead a solitary life.

They have been searching for the king the whole day, but he can't be found—the king himself decides whether he will be seen or not. Night has already fallen; only now does he cautiously move his ponderous body through the undergrowth, his enormous tusks shimmering wanly in the moonlight. The Zulus have given him the name Isilo—their word for "king of kings," and it is indeed difficult to imagine a more majestic creature. Measured at the shoulder, Isilo stands 13 feet tall, and he weighs close to 8 tons. His tusks are so long that they touch the ground, and they're the longest of any living elephant. The documentary filmmakers manage to capture Isilo's brief appearance before he vanishes back into the brush. These are to be the last images ever recorded of one of Africa's largest tuskers…

>

> "OLD EXPERIENCED MALES ARE CRUCIAL, THEY ARE SO MUCH MORE THAN SIMPLY BREEDERS. BY THE TIME THEY REACH THIS SIZE THEY HAVE ACCUMULATED SOCIAL AND ECOLOGICAL EXPERIENCE THAT THEY TEACH TO YOUNGER ANIMALS."
>
> —Vicki Fishlock,
> Amboseli Trust for Elephants

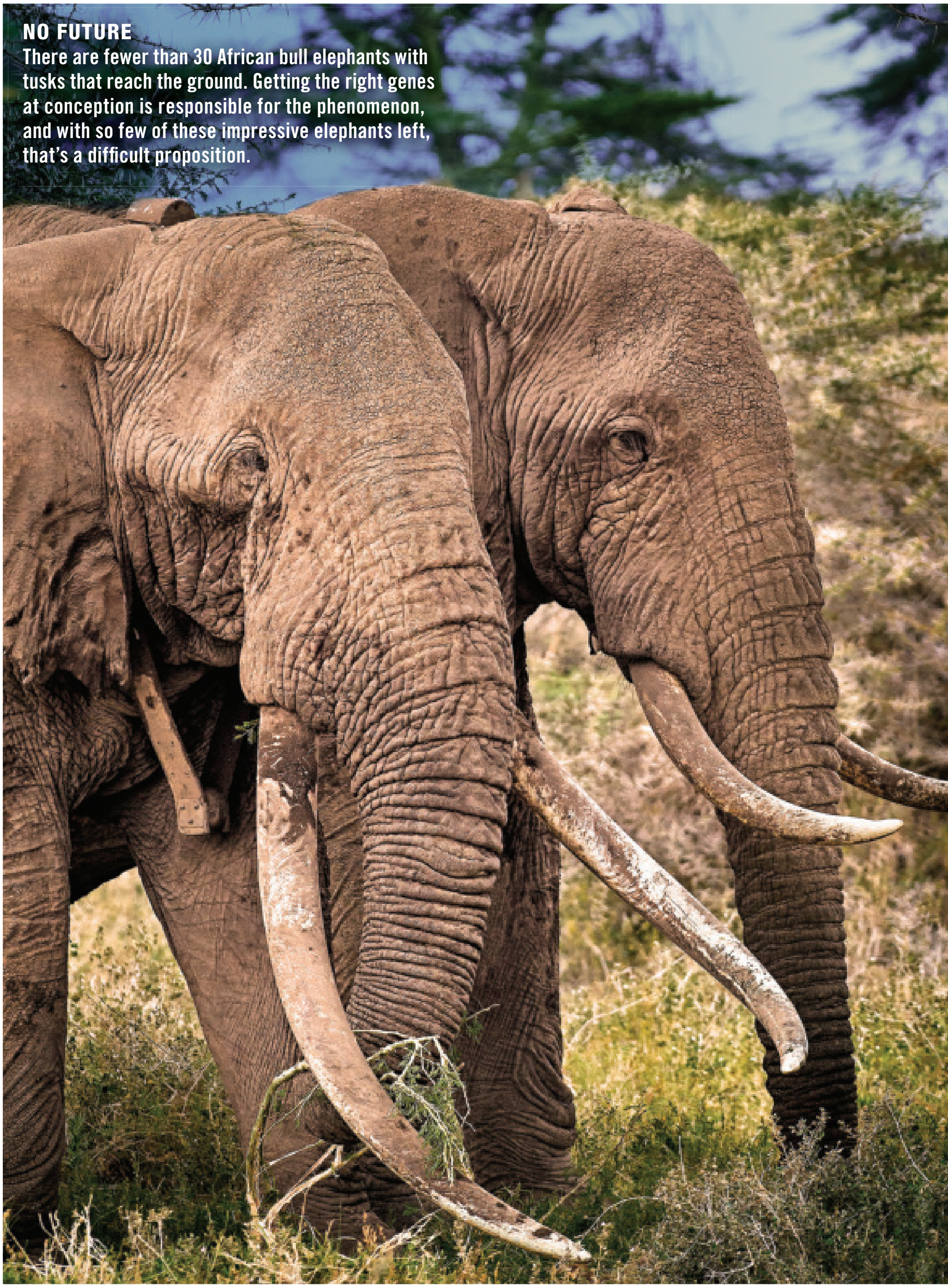
AN AFRICAN ELEPHANT IS KILLED EVERY 15 MINUTES. FEWER THAN 400,000 OF THEM ARE LEFT—AND ONLY 30 OF THESE ARE GREAT TUSKERS.

"Tusker" is both a badge of honor as well as a curse. The word designates any tusked animal, but in this context "great tusker" means a male elephant with a genetic makeup that enables it to grow tusks that reach the ground and that weigh more than 100 pounds each. Like all African elephants they are in sharp decline, and their tusks make them especially attractive prey for poachers and other illegal hunters.

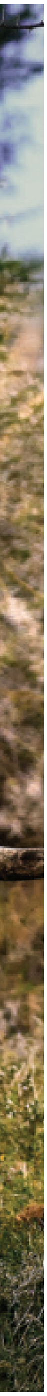
In the two decades between 1930 and 1950, the continent of Africa had been home to as many as 5 million elephants (*Loxodonta africana*), the largest land animal in the world. The main reason for the drastic decline: poachers, who kill an elephant every 15 minutes on average. The price of ivory has risen tenfold since the ivory trade was banned in 1989, making poaching ever more lucrative. In just one of many seizures made last year, authorities in Singapore confiscated almost 10 tons of illegal ivory, valued at $12.9 million and taken from nearly 300 elephants. So the few remaining great tuskers are a prized target, and their imperiled numbers are expected to dwindle further, not least because their tusks have produced "negative" Darwinian selection: Elephants with big tusks are more likely to be killed, which removes their genes from the pool. So tusks are generally smaller than they were 100 years ago.

Although banned in 1989, the ivory trade continues in many countries, driven by demand in the Far East. At its peak in 2014, raw ivory had been selling for almost $1,000 per pound on the wholesale market in China. A Chinese ban on the ivory trade took effect on the last day of 2017, which offered the tuskers some respite. The highly intelligent animals recognize the danger: "I have seen elephants attempting to hide their tusks when >

> "I HAVE SEEN ELEPHANTS ATTEMPTING TO HIDE THEIR TUSKS WHEN THEY KNOW HUMANS ARE WATCHING THEM."
>
> —Craig Millar,
> Big Life Foundation



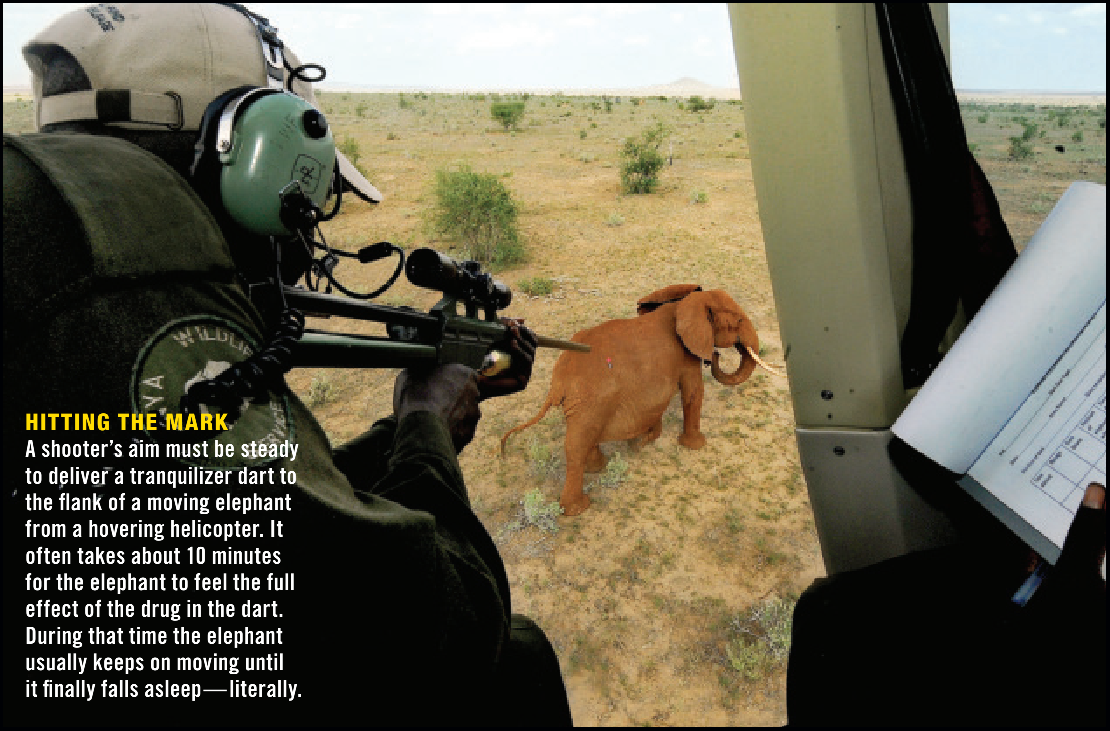
NO FUTURE
There are fewer than 30 African bull elephants with tusks that reach the ground. Getting the right genes at conception is responsible for the phenomenon, and with so few of these impressive elephants left, that's a difficult proposition.



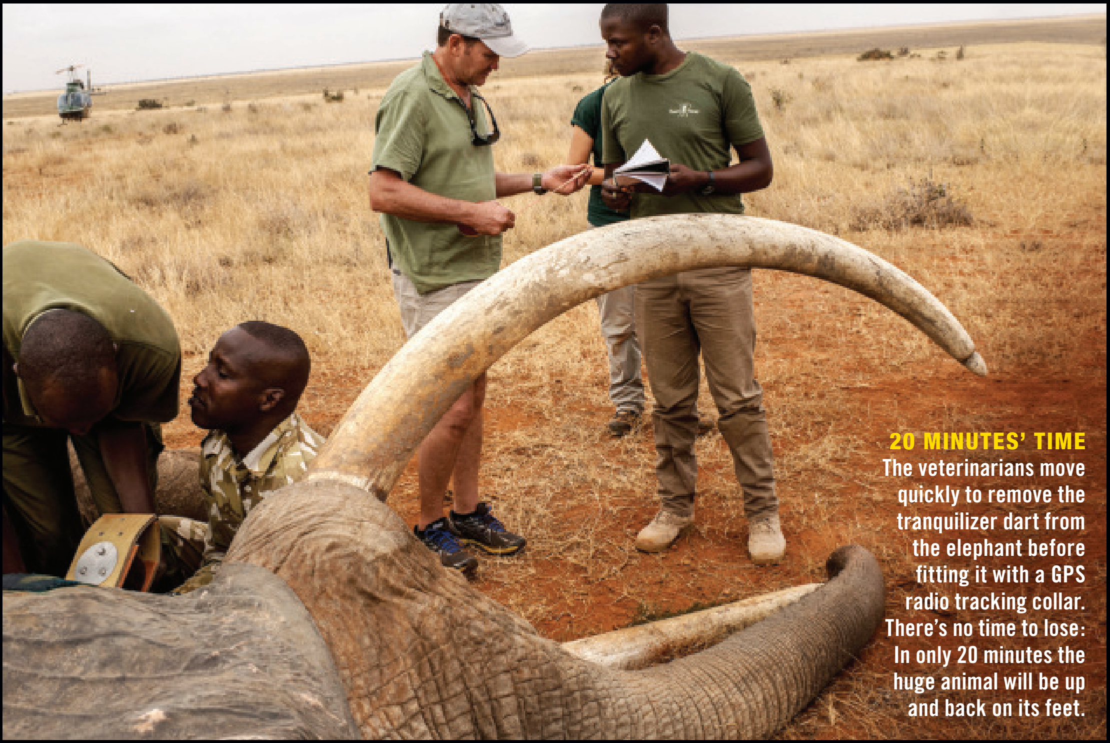
140 POUNDS EACH
Only 400,000 or so elephants remain in Africa, with about 13,000 of them living in Kenya's Tsavo National Park. The park had been home to an elephant bull named Murembo ("Beautiful One") whose tusks weighed at least 140 pounds each and touched the ground, making him a true "great tusker."

HOW DO YOU MONITOR AFRICA'S KINGS?

In one of the most sophisticated elephant-tracking endeavors in history, an international team of rangers, biologists, veterinarians, and pilots spent five days in Kenya's Tsavo ecosystem in early 2018, fitting elephants with advanced satellite radio tracking collars in order to monitor their movements. Twenty elephants (two of them classified as great tuskers) were tracked down with helicopters and immobilized from the air with anesthetizing darts. Crews on the ground used land vehicles to reach the animals and fit them with tracking collars.



HITTING THE MARK
A shooter's aim must be steady to deliver a tranquilizer dart to the flank of a moving elephant from a hovering helicopter. It often takes about 10 minutes for the elephant to feel the full effect of the drug in the dart. During that time the elephant usually keeps on moving until it finally falls asleep—literally.



20 MINUTES' TIME
The veterinarians move quickly to remove the tranquilizer dart from the elephant before fitting it with a GPS radio tracking collar. There's no time to lose: In only 20 minutes the huge animal will be up and back on its feet.

PHOTOS: Robru, 104kelly, brittak, Franz Aberham, MogensTrolle, Ghislain & Marie David de Lossy, Vicki Jauron Babylon and Beyond Photography (2), Tony Karumba/Stringer, Andrew Renneisen/Stringer (2)—all /Getty Images.

they know that humans are watching them," reports Craig Millar, the head of security for the Big Life Foundation, a conservation group that conducts coordinated anti-poaching operations in East Africa. Researchers have long recognized the truth in the old saying "an elephant never forgets," however elephants also have feelings beyond hunger, fear, and pain. It is clear they feel empathy, love, sorrow, and grief.

It's increasingly unlikely elephants the size of Isilo will be able to pass their instincts and knowledge on to the next generation. Male elephants can start mating at 15, but they don't do so regularly until age 35. Unlike most animals their reproductive drive increases as they get older, but many are killed by poachers before they can ever reach that stage.

The Tembe Elephant Park in South Africa, where Isilo died in 2014, is home to around 250 elephants that are among the largest in the world. The game reserve is one of the most secure refuges available, but no one can guarantee the absolute safety of the elephants. Isilo disappeared in early January, and his tuskless body was discovered in late March, though the 58-year-old is believed to have died of natural causes. His tusks were likely stolen later by poachers and taken to Mozambique about an hour away. So is this the end of the line for the great tuskers? Not necessarily. In February 2014 the Great Elephant Census began to count the remaining African elephants. The results were released in August 2016, and some of them shocked the world: Tanzania, for example, had seen a 60% loss of elephants since 2009. But there were also rays of hope: Uganda's elephant population had rebounded from fewer than 800 to some 5,000, and Zakouma National Park in Chad as well as Tsavo in Kenya reported strong herds with a promising number of calves. Tsavo reported several young males with the potential to be great tuskers. The king of kings is dead—long live the kings!

HERD INSTINCT
If a family of elephants hears an approaching helicopter or senses any other kind of danger, the members form a tight-knit group and try to make themselves the smallest possible target.

+++ WHO REALLY KILLED ROBERT KENNEDY?

+++ WAS MARTIN LUTHER KING, JR. THE VICTIM OF AN FBI PLOT?

+++ DID CLEOPATRA COMMIT SUICIDE?

+++ HOW DID CHE GUEVARA DIE?

COLD CA

THE UNSOLVED
OF HISTOR

ASES
MURDERS
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It is the year 1235, and a Chinese magistrate is called to a village to investigate a murder. Farmers have found the body of a man who has been stabbed and hacked to death. But rather than resorting to torture to find the killer—as would have been the case in Europe until the practice was abolished in the 18th century—the magistrate employs a revolutionary method: He conducts a crime scene investigation instead.

The magistrate orders a series of experiments to be performed on animal cadavers, cutting them with a variety of blades to determine the murder weapon, and finds that the man was killed with a sickle. He then convenes all the farmers who own one, some 10 in all, lines them up in a field with their sickles, and tells them to step back. Bluebottle flies begin to land on one—and only one—of the blades, and so the identity of the murderer becomes clear. While the killer had taken care to wash his sickle after the murder, tiny bits of blood and flesh—too small for the human eye to see—remained on the blade, and that has attracted the flies. Confronted with the evidence, the man confesses and is arrested. Thus the magistrate concludes what is probably the world's first scientific murder investigation, and forensic medicine is born.

The method was described in a book written a few years later by the Chinese physician Song Ci (1186–1249). Frustrated by a series of obvious miscarriages of justice, he wrote *Collected Cases of Injustice Rectified,* the first book on the topic of forensic science. The unique five-volume work contains instructions for conducting post-mortem examinations, describes the different appearance of corpses depending on the cause of death, and lays out methods for treating various injuries.

In the modern era, the toolbox of the forensic scientists has grown to include ballistics, fingerprint analysis, facial reconstruction, and DNA sequencing. The last one in particular sometimes helps investigators solve crimes that had been committed decades or even centuries earlier. On the pages that follow we take a new look at some of the most famous "cold cases" of world history that are still of interest today. Fortunately—or unfortunately, depending on one's point of view—there is no statute of limitations on murder…

WAS THE CIVIL RIGHTS LEADER THE VICTIM OF AN FBI CONSPIRACY?

Night was falling on April 4, 1968, as Martin Luther King, Jr. stepped out on the balcony of the Lorraine Motel in Memphis, Tennessee. At 6:01 P.M. a shot rang out, and a bullet struck King in the cheek, breaking his jaw, severing several major arteries as it traveled down his spine, and killing him. A short time afterward police discovered a bundle containing a Remington rifle near the boarding house across the street. A huge FBI manhunt for the killer led agents to an Atlanta apartment, where they found the fingerprints of James Earl Ray, who'd escaped from a prison in Missouri a year earlier. Ray was subsequently arrested in London and extradited to the United States in July of 1968. To avoid the death penalty, he confessed to the killing but retracted his confession soon after being sentenced to 99 years in prison. Ray had continued to assert his innocence until his death in 1998. Five years prior to that, Loyd Jowers, who owned a restaurant near the Lorraine Motel, appeared on a U.S. TV network to reveal details of a conspiracy allegedly hatched by the U.S. government and the Mafia to assassinate Dr. King. Jowers claimed he had hired a Memphis police lieutenant to fire the fatal shot. The King family became convinced that Ray was not the gunman, and they filed and won a wrongful death lawsuit against Jowers. But the verdict did nothing to free Ray or secure a new trial. At a press conference, Dr. King's widow, Coretta Scott King, had said, "There is abundant evidence of a major high-level conspiracy in the assassination, involving the Mafia as well as local, state, and federal agencies." U.S. Attorney General Janet Reno ordered a new investigation, but the report rejected the idea of a conspiracy. So who really killed Martin Luther King, Jr.? For some people, that remains an unanswered question.

WITHOUT A LEADER
The assassination of the most prominent leader of the American civil rights movement was a tremendous loss for activists. But the sanitation workers' strike that Dr. King had come to Memphis to support ended successfully and was a turning point in black activism.

WHY DID THE SECRETARY GENERAL OF THE UN **HAVE TO DIE**?

The shocking wreckage was found on the afternoon of September 18, 1961, around 15 hours after the crash. The Douglas DC-6B had been carrying UN Secretary General Dag Hammarskjöld to a meeting where he would be discussing a peace plan with Moise Tshombe, the leader of separatists in Congo's secessionist state of Katanga. Sadly, 15 of the occupants were dead, and the 16th died of his injuries days later. The crash occurred late at night, not far from the airport of Ndola, a large town in what is now Zambia. No one has ever been able to determine the cause of the crash with certainty, despite the three investigations that were conducted at the time. In 2015 the UN appointed a panel of experts to review the findings. The report that came out two years later said a conspiracy couldn't be ruled out: "It seems plausible that an external attack or threat caused the crash." But why would someone want to kill Dag Hammarskjöld?

For years the Swedish diplomat had been concerned about violence between Israel and the Arab states in the Middle East, and for his efforts he was posthumously awarded the Nobel Peace Prize. But in 1960 he'd sent a UN force to the Republic of the Congo after it became independent from Belgium and fighting had broken out between the new government and Tshombe's separatists, who sought control of mineral-rich Katanga. For his efforts in the Congo Hammarskjöld was denounced by the Soviet Union, which called for his resignation. Congo's prime minister, Patrice Lumumba, sought Soviet assistance in fighting the rebels, while Belgium and its Western allies supported them, so the Congo crisis became a burning East-West issue. Lumumba was arrested in late 1960 and turned over to the Katanga regime, which murdered him in the presence of Belgian officers. There were also indications of U.S. and possibly British involvement in plots to murder Lumumba. The mysterious incident that had killed Dag Hammarskjöld also has a potentially large cast of characters, including the Congolese separatists, Belgian diamond merchants, mercenaries from Europe, a South African paramilitary group, and the CIA. Speculation that Hammarskjöld's plane was shot down or sabotaged gained traction in 2011 with the publication of *Who Killed Hammarskjöld: The UN, the Cold War and White Supremacy in Africa.* The book has kept interest in this cold case alive.

> "Evidence indicates there was more than one plane and that the DC-6 was actively engaged by another aircraft."
>
> **Mohamed Chande Othman, former chief justice of Tanzania**

WAS SOUTH AFRICA'S APARTHEID REGIME BEHIND THE CRASH?

Dag Hammarskjöld's nephew Knut flew to Ndola to collect his uncle's belongings and found that his attaché case remained uncharred despite the fire that had engulfed the DC-6. "For me there has always been a question mark over the whole affair," he'd said. In 1998 South Africa's Truth and Reconciliation Commission published eight letters suggesting the involvement of British, American, and South African intelligence agencies.

DID FAMED ASTRONOMER JOHANNES KEPLER POISON HIS MENTOR?

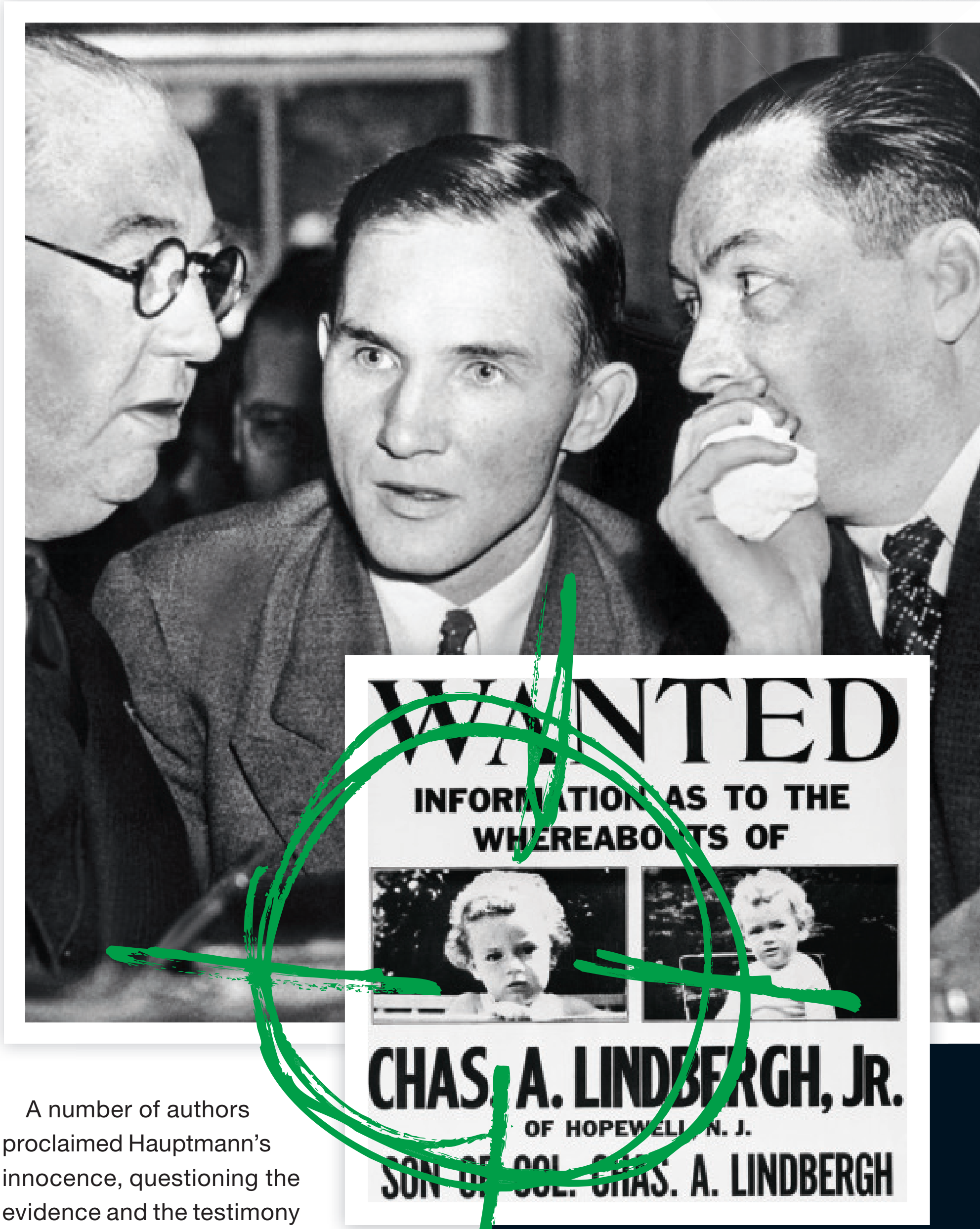
Modern forensic methods can solve a centuries-old murder—or exonerate someone who was falsely accused at the time. That is the case with one of the world's greatest astronomers, Johannes Kepler (1571–1630), who worked as an assistant to the Danish astronomer Tycho Brahe before achieving renown of his own. There is speculation that on the evening of October 13, 1601, Brahe was on the verge of a revolutionary discovery that would change our understanding of the world. That evening he dined with his patron, Emperor Rudolph II, in Prague, and only 10 days later he was dead. What had killed him? According to legend, Brahe was too polite to excuse himself from the table when he badly needed to urinate and died after his bladder burst and an infection set in. But there are other, much more sinister theories as well. Perhaps he was poisoned by his former patron, the king of Denmark? Or perhaps his ambitious assistant Johannes Kepler used mercury to do the deed. Kepler later gained fame by publishing the three laws of planetary motion. Had Brahe been on the verge of revealing that great discovery when he unexpectedly died? Kepler's laws state all the planets, including the Earth, orbit around the Sun, a line segment joining any planet and the Sun sweeps out equal areas in equal lengths of time, and the square of the orbital period of a planet is directly proportional to the cube of its mean distance from the Sun. According to the murder theory, these then-revolutionary principles might well be known as "Brahe's laws" had Brahe lived. Over the centuries the story of the alleged poisoning refused to die, and tests conducted in 1996 on samples of Brahe's hair did indeed show unusually high levels of mercury. However in 2010 forensic scientists once again exhumed Brahe's body and said it was clear if he had been murdered, mercury wasn't the weapon: "The concentrations were not sufficiently high to have caused death," they wrote.

CHARLES LINDBERGH, JR.

WAS THERE A COVER-UP FOR A FATAL ACCIDENT?

On the evening of March 1, 1932, 20-month-old Charles Augustus Lindbergh, Jr. disappeared from his nursery on the second floor of the Lindbergh home in Hopewell, New Jersey. A ransom note was found on the nursery windowsill, and the New Jersey State Police opened an investigation. They discovered traces of mud on the nursery floor, footprints beneath the window, and sections of a broken ladder outside, but there were no bloodstains or fingerprints. The baby's father, Charles Lindbergh, was famous for having made the first nonstop solo flight across the Atlantic, flying from New York to Paris on May 20–21, 1927, and the disappearance of his son soon made the international headlines. As the days passed by, a total of 11 more ransom notes would arrive by messenger or mail. And then on May 12 the baby's body was found in a grove of trees less than five miles from the Lindbergh home. His head had been crushed, some of his members were missing, and the disappearance had become a murder. FBI Director J. Edgar Hoover offered his assistance.

Lindbergh arranged for the payment of $50,000 after receiving the ransom notes, one of which had been postmarked from Brooklyn, and the FBI had notified banks in the New York area to be on the lookout for the serial numbers. On September 15, 1934, an alert gas station attendant jotted down the license plate number of a man who'd paid with one of those bills. The car belonged to Bruno Richard Hauptmann, a native of Germany. The FBI's new crime lab found handwriting similarities between Hauptmann and the author of the ransom notes, and marks on the ladder matched tools owned by the German carpenter. On the basis of this circumstantial evidence Hauptmann was tried, and after a month he was found guilty on February 13, 1935. Just over one year later he was executed, and he denied his guilt to the end.



WANTED

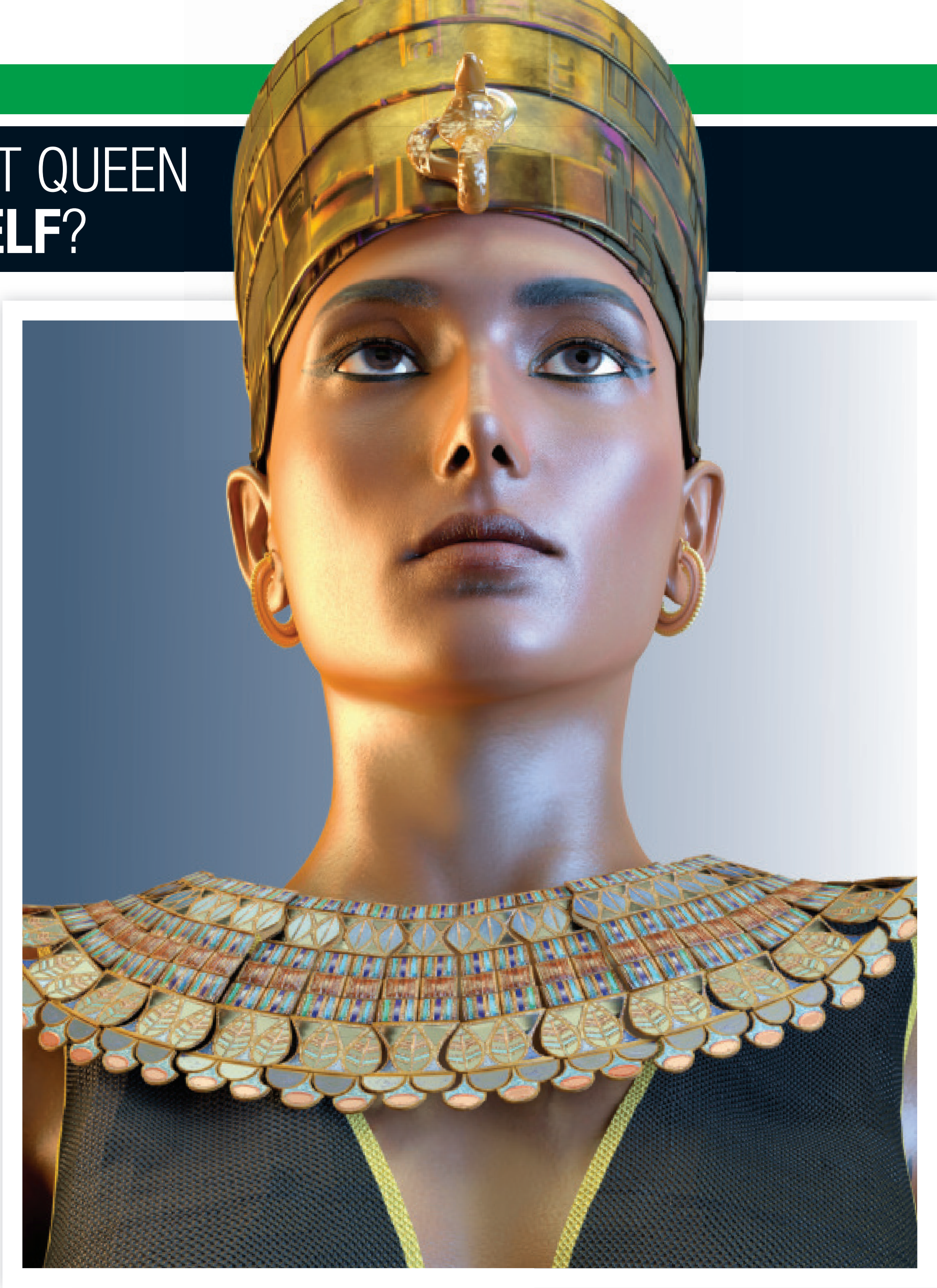
INFORMATION AS TO THE
WHEREABOUTS OF

CHAS. A. LINDBERGH, JR.
OF HOPEWELL, N. J.
SON OF COL. CHAS. A. LINDBERGH

SCAPEGOAT?
Bruno Richard Hauptmann (at center in the photo) was arrested on September 19, 1934, and charged with murder. The evidence at the "trial of the century" was circumstantial, but Lindbergh himself testified that he recognized Hauptmann's voice from hearing it on the night of the ransom payment, although almost three years had passed in the meantime. Experts today challenge that feat of memory. Hauptmann was found guilty on February 13, 1935, and electrocuted on April 3, 1936.

A number of authors proclaimed Hauptmann's innocence, questioning the evidence and the testimony of witnesses. According to one theory, Lindbergh "kidnapped" his son to alarm the staff, but in making his descent on the ladder he dropped the infant, who'd sustained fatal injuries. Lindbergh had allegedly been known to play cruel jokes and had hidden the baby in a closet two months earlier to alarm his wife. If this conjecture is true, Lindbergh let another man be executed rather than admit what he himself had done.

DID EGYPT'S LAST QUEEN REALLY KILL HERSELF?

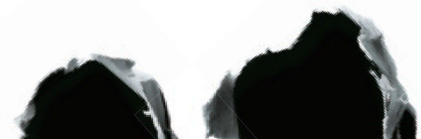


In 29 BC Octavian was approaching the height of his power: The Roman political figure who would soon be known as Caesar Augustus celebrated three great military triumphs on consecutive days in August, the month that was later to be named for him when the Gregorian calendar was invented. One was over Egypt and its famous queen, Cleopatra, and in his triumphal procession in Rome he paraded her children along with an effigy of the queen herself, an asp clinging to her body. She'd died one year earlier along with her husband and Octavian's rival, Mark Antony. The queen's effigy entrenched for all time the legend of her death: Cleopatra is said to have committed suicide by allowing an Egyptian cobra called an asp to bite her, and she allegedly remained beautiful even in death. This story is found in the works of contemporary poets, such as Virgil and Horace, and it was also a recurrent theme in Medieval and Renaissance art. It is moving, but did it actually occur? Forensic scientists are skeptical: "Death from an asp bite may happen within 45 minutes, but it can take longer," says Dietrich Mebs, a toxicologist and the author of *Venomous and Poisonous Animals.* "And the dead body does not look nice after suffering vomiting, diarrhea, and swelling." Contemporary accounts do not say a snake was found in the room. While Plutarch mentions an asp, he also suggests a hollow instrument could have caused her death. Others suggest needles or hairpins caused puncture wounds on her arm, and the Roman physician Galen suggests Cleopatra bit her own arm and then introduced poison. Modern researchers say a cobra's bite is not always fatal and would not have been chosen by a woman intent on suicide. The Roman historian Cassius Dio, writing 200 years later, describes a "quiet and pain-free death." For toxicologist Mebs, that would suggest a mixture of opium, hemlock, and wolfsbane. And his colleague Christoph Schaefer agrees: "Opium is quiet, and one can fall into a deadly sleep." Some historians say Octavian may have compelled Cleopatra to kill herself by threatening to parade her through Rome as he later did with her children. In any event, the demise of the last queen allowed the great Roman ruler to add Egypt to his string of acquisitions.

THE LAST RULER OF PTOLEMAIC EGYPT

Cleopatra VII Thea Philopator (Greek: "Goddess Who Loves Her Father") ruled ancient Egypt from 51 to 30 BC. To maintain her independence from Rome, she took two of the empire's most powerful men as her lovers: Julius Caesar and later Mark Antony. But in the end she was defeated by another: Octavian, who was destined to become Caesar Augustus. In dying a mysterious death she became a legend, as documented in countless paintings, scores of films and operas, and 200 novels and plays, including Shakespeare's celebrated tragedy *Antony and Cleopatra.*

"It is certain that there was no cobra. It is a horrible death, and it doesn't go quickly. Opium is quiet, and with it one can fall into a deadly sleep."



DID THE ASSASSIN SIRHAN SIRHAN ACT ALONE?

For the United States, 1968 was an extremely traumatic year of assassinations, race riots, and war. In January the Tet Offensive convinced many Americans that the Vietnam War could not be won. In late February news broadcaster Walter Cronkite stunned the nation by saying he agreed, and a month later President Lyndon Johnson halted his re-election campaign. Senator Robert F. Kennedy had recently entered the race, but the outcome was unclear: The remaining competitor, Senator Eugene McCarthy, did unusually well against Johnson in New Hampshire. However a short time later Kennedy defeated McCarthy in Nebraska and seemed to be firmly on a path to the Democratic nomination. On the night of June 6, Kennedy was celebrating his victory in Los Angeles when shots rang out at the Ambassador Hotel. He was mortally wounded and died 26 hours later. Several men subdued and disarmed 24-year-old Sirhan Sirhan, a Palestinian Christian who was said to have been angered by Kennedy's support for Israel. He was convicted of murder in April 1969 and received a death sentence, which was later commuted to life in prison.

Like the assassination of John F. Kennedy, the killing of his younger brother led to conspiracy theories. The Irish filmmaker Shane O'Sullivan alleged several CIA officers were at the Ambassador Hotel on the night of the murder. The LA Police Department later determined two of the men he identified were sales managers for the Bulova watch company attending a convention. O'Sullivan had countered that Bulova was a "well-known cover for the CIA." A number of forensic audio specialists asserted that more shots were fired than the eight-bullet capacity of Sirhan's gun. But others said that they had heard no more than eight gunshots on the recording. Assertions of a second gunman were supported by the medical examiner at the time and they were investigated by order of the U.S. Supreme Court in 1975. The examiner said the fatal shot had been fired from a distance of an inch behind Kennedy's ear. Although witnesses said Sirhan fired from the front, the court concluded that there was too little evidence to support the theory of a second gunman. Lawyers for Sirhan have petitioned for parole on more than 10 occasions without success. The next hearing is set for 2021. Is the wrong man behind bars?

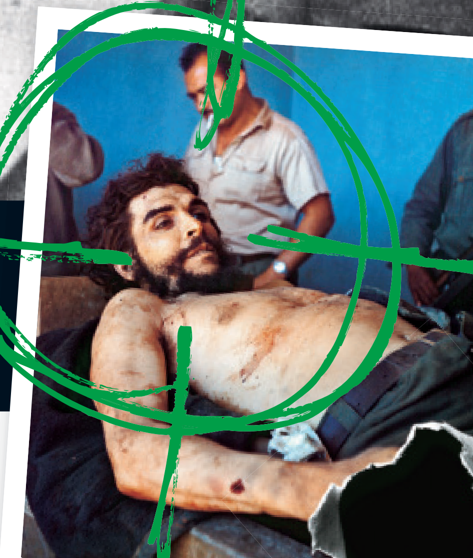
ENDURING DISCREPANCY
The medical examiner at the time said the shot that killed Kennedy was fired from a distance of an inch behind his right ear. But some witnesses said Sirhan Sirhan was standing in front of Kennedy when he fired. How is that possible?

HOW DID THE MARXIST REVOLUTIONARY DIE?

The revolutionary leader's plans came to an abrupt end on October 8, 1967, near the small Bolivian village of La Higuera. Soldiers found Ernesto "Che" Guevara lying in a ravine after being shot in the calf. He identified himself: "I am Che Guevara, and I am more use to you alive than dead!" They carried him on a blanket to the schoolhouse in La Higuera and waited for further orders, which came the next day.

At dawn, Bolivian Colonel Joaquín Zenteno Anaya, accompanied by CIA agent Félix Rodríguez, arrived by helicopter. Rodríguez transmitted a message to CIA headquarters to inform the agency of the capture and ask what was to be done with Guevara. The CIA indicated that it wanted him to be taken to Panama for questioning. However Bolivian President René Barrientos had ordered Guevara's death, and his soldiers obeyed. They killed Guevara in a burst of gunfire. The government solemnly announced the death, claiming Guevara had died in combat.

This story, as recounted by Gary Prado Salmón, a soldier who was there at the time, and which was confirmed by U.S. government documents, makes it clear that Guevara's death was cold-blooded murder. The Bolivian government was soon forced to retract its story after reports emerged of Guevara being seen alive in La Higuera. But why didn't they simply put Guevara on trial? Prado believes the president wanted to avoid hearings that "would have become a cause célébre" and attracted thousands of journalists. Another problem: Bolivia does not have the death penalty (the United States is the only nation in the Americas that does), and the maximum jail sentence was 30 years. "We did not have any secure jails in Bolivia," said Prado, "and there would always have been people attempting to liberate him. Therefore we executed Che Guevara to get rid of the problem."

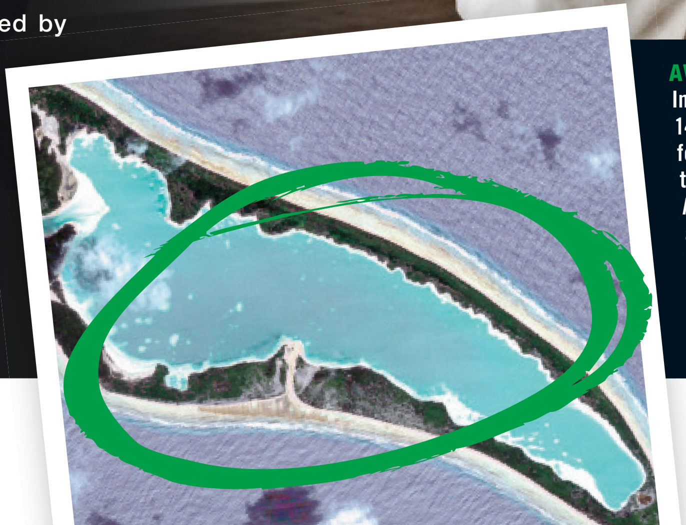


BIRTH OF A MARTYR
The body of Che Guevara (colorized photo) was put on display in the provincial capital of Vallegrande. Bolivia had wanted to prove to the entire world that the guerrilla leader was dead in order to prevent his becoming a martyr. Publication of this photo ultimately had the opposite effect, and a legend was born.

HOW DO YOU FIND A **MISSING PERSON MORE THAN 80 YEARS LATER**?

“KHAQQ calling Itasca: We must be on you but cannot see you. Gas is running low.” The SOS came at 8:43 A.M. on July 2, 1937, and then all contact was lost. The message had been received aboard the Coast Guard cutter USCGC *Itasca,* stationed at Howland Island in the central Pacific Ocean, where its mission was to help Amelia Earhart locate the small island. On that morning in 1937, one of the world’s most famous women had already flown three-quarters of the way around the world in her effort to be the first aviator to circumnavigate the globe at the equator. But Earhart and her navigator, Fred Noonan, never reached Howland Island. *Itasca* began searching for them and was soon joined by the battleship *Colorado* and the aircraft carrier *Lexington,* but an oil slick was never found. Investigators concluded Earhart and Noonan had crashed and immediately sunk.

But years later a Texas woman, Mabel Larremore, would recount that on the night Earhart disappeared she had heard an SOS on a frequency that President Roosevelt had suggested. It was Earhart asking for help: “She said the plane was down on a small uninhabited island and that her navigator was seriously injured,” Larremore recalled. She told no one at the time because she’d assumed the authorities would be handling the matter. In 1940 bones were found on Nikumaroro Island, 400 miles from Howland. They were examined by a doctor in Fiji who concluded they were from a male. But in 2018 those findings were re-examined by Dr. Richard Jantz, a University of Tennessee forensic anthropologist. His analysis “strongly supports the conclusion that the bones belonged to Amelia Earhart,” he says, or that “they are from someone very similar to her.” The quest for the truth of the matter continues.



AVIATION HEROINE
In 1922 Amelia Earhart flew a plane to 14,000 feet, setting an altitude record for a female pilot. In 1932 she became the first woman to fly solo across the Atlantic Ocean. By 1937 Earhart had also become a best-selling author and a personal friend of First Lady Eleanor Roosevelt. Shown at left: Nikumaroro, the Pacific island where she may have died.

PHOTOS: UniversalImagesGroup, Joseph Scherschel, Stock Montage—all/Contributor/Getty; Archive Photos, Hulton Archive, Denis-Art, MPI/Stringer—all/Getty; Getty Images (9); Fotofinder/Leemage; United Archive; Mauritius; dpa Picture-Alliance (2); Laif; Interfoto; ddp.

THE INCREDIBLE POWER OF INTUITION

Whom do we trust? How reliable are our gut feelings? And how do they help us make decisions? New studies show that intuition influences our lives much more than previously believed—and it works faster than the conscious mind can even think…

He had long since paid for the ticket and had printed his boarding pass only a short time earlier. But at the last minute Kevin Donahue* decided not to board the aircraft. "I'd had a sudden bad feeling, an instinct," he recalls. It was an impulse that saved his life: Only a few minutes after the takeoff an equipment failure caused the plane to plummet from the sky in a catastrophic crash. Later, during sessions with a psychotherapist, Donahue realized that his survival was not the product of accident or fate: His subconscious mind had saved him. During his therapy time, the 45-year-old engineer gradually began to remember what had first triggered the unease he'd felt at the time: the sweat-soaked shirt of the pilot who arrived at the gate shortly before the scheduled departure as well as the troubling gestures of the mechanics he glimpsed outside on the tarmac. The memories seemed to fit together like puzzle pieces, forming a whole image and shaping Donahue's decision. His brain had registered these as danger signals, and his intuition worked overtime to help him make the correct decision. The same kind of thing happens to each of us thousands of times per day—with the important difference that it is not usually a matter of life and death...

"YOUR SUBCONSCIOUS MIND CAN SEE SOMETHING WITHOUT YOUR KNOWING YOU SEE IT—AND PROCESS IT IN LESS TIME THAN IT TAKES YOU TO BLINK."

Katharine Blackwell, psychologist

Neurologists have discovered that the subconscious mind is constantly conducting risk analysis without our being consciously aware of it, with the brain scanning the input from our sensory organs to detect patterns of possible risk. For example, soldiers, firefighters, mountain climbers, and surfers react intuitively to situations based on all the experiences that are stored in their subconscious minds. They don't consciously calculate how many enemy soldiers are concealed in the brush, how many minutes the stairway in the house can withstand the flames, where the next boulder is likely to break loose, or where the current might be fatally treacherous. And yet experienced people (usually) make sound decisions.

Intuition, which is often described as a gut feeling, has something of a supernatural quality about it, like a kind of mystical inspiration that runs counter to the laws of logic. Gradually, however, science is coming to accept the conclusion that the opposite is the case. Neurologists and psychologists are finding that our intuition is much more tangible and measurable than previously believed. It conforms to certain rules and is frequently more reliable in aiding decision-making than the conscious mind. Will my car fit in that parking space? Can I swim

>

*Name has been changed by the editors.

INTUITION IS THE BODY'S NATIVE LANGUAGE IN WHICH IT TRANSMITS SIGNALS FROM THE ORGANS TO THE SUBCONSCIOUS MIND.

from the boat to the beach? Should I take that shortcut through the dark underpass? Our intuitive intelligence can answer such questions faster than the blink of an eye.

> "A SMART MOTHER OFTEN MAKES A BETTER DIAGNOSIS THAN A POOR DOCTOR."
>
> ***Dr. August Bier (1861–1949)***

A review of 30 studies on the topic of how serious infections become diagnosed in children shows the combined intuition of mothers and doctors makes a correct diagnosis much more likely. Parental concern that a new illness "seems different" makes it 14 times more likely that a serious infection is present. And a doctor's intuition that "something is wrong" is an even more effective predictor, making it 24 times more likely that the child is seriously ill.

Intuition plays an important role in our personal health, too. A pleasant tingling sensation, a feeling of warmth in your stomach, or having a swelled chest—a lump in the throat, butterflies in the stomach, or tense muscles: All of these feelings convey important information about the state of your body. Researchers have come to the realization that intuition is the body's native language in which it transmits signals from the various organs to the subconscious mind. In this regard, brain researchers speak of "somatic markers," emotions that influence our behavior. That's not surprising: There are some 100 billion neurons in the human brain. Bundles of nerve fibers connect them to the 500 or so million neurons in the gut—the gut-brain axis. One of the biggest connections is the vagus nerve, which sends signals in both directions. That explains why we can have gut feelings as well as butterflies in our stomachs. Many of the neurotransmitters that the body produces, including a great deal of the "feel-good" chemical serotonin, are made in the gut. And heeding the signals the gut sends to the brain can protect us from harm: Psychologist Marcia Emery has found that people who trust their intuition are less likely to hurt themselves or suffer from chronic diseases.

Also astonishing: Our gut feelings about other people can be surprisingly accurate. Professor Nicholas Rule, now at the University of Toronto, was intrigued as a graduate student when he was told Mormons believe they can recognize other Mormons. When he studied a series of pictures of Mormons and non-Mormons, he had felt skeptical at first. "Nothing popped out that appeared obviously different," recalls the psychologist. However a study he devised showed that both Mormon and non-Mormon test subjects were able to identify pictures of Mormons more often than could happen simply by chance. He set out to find the telltale difference, eliminating any features that might potentially be involved: hair, eyes, nose, and mouth. The test subjects could still tell. In the end he realized that it was the condition of the skin: The test subjects felt that there was a connection between health and Mormonism, and the Mormons' skin just looked healthier. (Mormons are known to enjoy excellent health, in part because they do not smoke or consume alcohol, coffee, or tea.) As Rule concluded, "The study shows how tiny pieces of information can have a big effect, and we don't even know it's occurring."

From the time we're born, we are constantly evaluating experiences and cataloging them as positive or negative. Thus we amass a gigantic storehouse of information that our brain uses to construct its rules of thumb. Our subconscious intelligence knows which rules to apply in a given situation to make things work in our favor, and it does that all the time in almost every situation. So it doesn't >

matter whether we're deciding to buy shares in a company or a new car, or simply trying to estimate our distance away from an object: Intuition always plays a significant role and sometimes provides better advice than we'd get from conscious thought.

A possible explanation: information overload. The subconscious mind is able to process around 11 million items of information per second while conscious processing can handle only about 40 items in the same span of time. If we wanted to make the very best decision using only conscious thought, then our brains would have to consider every individual factor, and given the processing speed of conscious thought and the time that's available to us, it's just not possible. In many cases, the only real answer is to trust our intuition to make the right decision based on gut feeling. And this works more often than you might imagine…

> “LEARNING TO TRUST IS ONE OF LIFE'S MOST DIFFICULT TASKS.”
>
> ***Isaac Watts (1674–1748)***

45%: less than a vote of confidence. Professor David Dunning of Cornell University conducted a study that indicated people are often cynical about their fellow humans, even if there's little justification. His subjects expected only 45% of other people to be trustworthy.

In the experiment, Dunning asked participants what would happen if they gave money to strangers who could quadruple the amount. The strangers could then opt to keep all of the money or refund the subject twice the original amount, keeping half for themselves. Only 45% of the subjects expected to get any money back. But it turned out 80% of the strangers were willing to split the money even though there was no penalty for keeping all of it. So had the subjects based their decision on a bad experience? That's not a sound idea: “One person's bad behavior is not a good reflection of humankind in general,” says Dunning. “Rather than living your life on high alert, you must be willing to be vulnerable. No one wants to live in a world without trust.” Dunning has repeated the U.S. experiment in Germany and the Netherlands with similar results.

Trust is governed to some extent by reciprocity—we tend to trust people who trust us. And it should come as no surprise that the ability to trust is quite beneficial in a business career: Studies have shown that it is not the most ambitious employees who get ahead but rather the most trusting.

Lisa DeBruine, a psychologist at Canada's McMaster University, has performed an experiment similar to Dunning's but restricted interaction between participants to a computer link that allowed each participant to see an image of the other's face. The images were actually composites of two people's faces, either combining the subject's real face with that of a stranger or combining the faces of two strangers. Around two-thirds of the time subjects trusted a face that resembled their own, and they trusted unfamiliar faces only about half the time. The general finding: We're more likely to trust people who look like us. Other studies have found that we tend to trust religious people more than nonbelievers, women more than men, and seniors more than teenagers. It's another product of our intuition, which compares images and situations to its wealth of stored experiences and makes decisions in a split second. But experience has shown that we should not rely solely on our intuition.

THERE ARE 500 MILLION NEURONS IN THE HUMAN GUT.

Gut feelings can also be a response to prejudice. Numerous experiments have shown that people sometimes rely on minor details to draw rather comprehensive conclusions about someone they've just met. Our preconceived notions can, for example, lead us to a misguided conclusion, like: “Dark-skinned bearded men with backpacks are potential terrorists.”

Therefore when should we rely on our intuition—and when should we step back and rationally analyze a situation? Experts recommend that we let the situation decide. The more experience we've had with a given situation and the more familiar we are with its context as well as its possible ramifications, the more we can rely on intuition. Rational thought is the order of the day, however, when we're facing a totally new challenge with possibly unforeseen consequences. In that case it's prudent to carefully consider the various factors affecting our decision and to think through a number of the potential scenarios. At the same time, though, we should never completely ignore our intuitive intelligence. Psychologist Dan Zakay says feelings can provide decision-makers with information about the accuracy of their knowledge. Even a feeling of “knowing that you don't know” can inform them as to whether they can trust their knowledge and base judgments on it. As we saw in the case of Kevin Donahue, intuition can save lives. In one way or another, it does so every day for all the people who listen to it…

7 QUESTIONS ABOUT INTUITION

1 HOW CAN I TRAIN MY INTUITION?

Anyone can use simple exercises to test how well intuition functions in daily life. Ask yourself specific questions, such as "When will the guests I invited actually arrive at my party?" or "What time will my colleague stop working and go home?" If you do these exercises regularly, you will probably realize that you are right more often than you would have anticipated. When you get home at night, review the intuitive decisions you've made during the day. Ask yourself whether they were right or wrong, and try to remember what it was that prompted you to make those choices. In general, the less experienced you are in a given situation, the more you should make a conscious decision about how you are going to react.

2 WHAT INFLUENCES MY INTUITION?

Fatigue, posture, and experience—all of these factors influence decision-making. Studies have shown people make better decisions when they're rested, and those in a good mood are more generous than those who are grumpy. We tend to work more creatively when we're standing and put more trust in our intuition when we're literally in the dark. We also tend to choose the riskier options when we feel stressed. And people with more than five years of experience in a given field have a 70% likelihood of making the correct decision based on their spontaneous gut feeling.

3 WHAT IS NEGATIVE INTUITION?

We begin deciding at a young age how much we're going to trust our fellow folks. If kids grow up in an emotionally secure environment, surrounded by the love and support of their parents, they will emerge from childhood with a basic sense of trust. But if a child experiences emotional or physical violence, a feeling of insecurity becomes firmly established. As an adult, such a person will find it difficult to trust others. His immediate response is based on negative intuition: Because gut feelings are the result of experience, the person's intuition, when deciding whether or not to trust another person, will decide against trust, even if there's no plausible or rational reason for doing so.

4 DOES THE BRAIN HAVE A "CONFLICT ALARM"?

Psychologist Wim de Neys says a specific region of the brain, the anterior cingulate cortex (ACC), helps us to detect biased intuitions and becomes active if we are basing a decision on a hunch. The ACC also registers the conflict many people feel when they are tempted to commit an immoral act. Researchers find that the ACC remains inactive in psychopaths, who feel no conflict when they lie, for example.

5 HOW DO WE MAKE DECISIONS?

Psychologist and author Gerd Gigerenzer identified two types of decision-makers he calls "maximizers" and "satisficers." Maximizers weigh their choices carefully before making a decision, even if they're only deciding which TV program to watch or which item to buy in a store. Satisficers, on the other hand, readily accept a choice they regard as "good enough" instead of holding out for the "best."

6 WHAT DOES MY INTUITION KNOW ABOUT MY BODY?

Studies have shown that people who do not heed the warning signals relayed by their body are likely to take greater risks when making decisions about their health. Such individuals may agree more readily, for example, to having an operation. But a patient's input is vital. Kaiser Permanente, the largest managed-care organization in the United States, recommends full patient participation in all healthcare decisions: "Receive complete information about your care, the standard treatment options, and all the benefits, risks, and alternatives of recommended treatments or procedures." This will help protect you.

7 CAN YOU LOSE WEIGHT INTUITIVELY?

Experts advise eating more intuitively. That means only eating if you're actually hungry and only the foods you really want. Nutrition and fitness guru Ben Coomber says: "Eat what you want in amounts that make you happy, and learn to listen to your body. It may or may not cause weight loss, but it can improve your health."

PHOTOS: PeopleImages, Kesus01, OSTILL, urfinguss, SCIEPRO/SCIENCE PHOTO LIBRARY, rubberball, Klaus Vedfelt, Kativ—all /Getty Images.

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50TH ANNIVERSARY

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July 20, 1969
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EVA: 2h, 31m
Sea of Tranquility
0.71° n, 23.63° e

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HOW

THE WORLD’S BIGGEST CRO

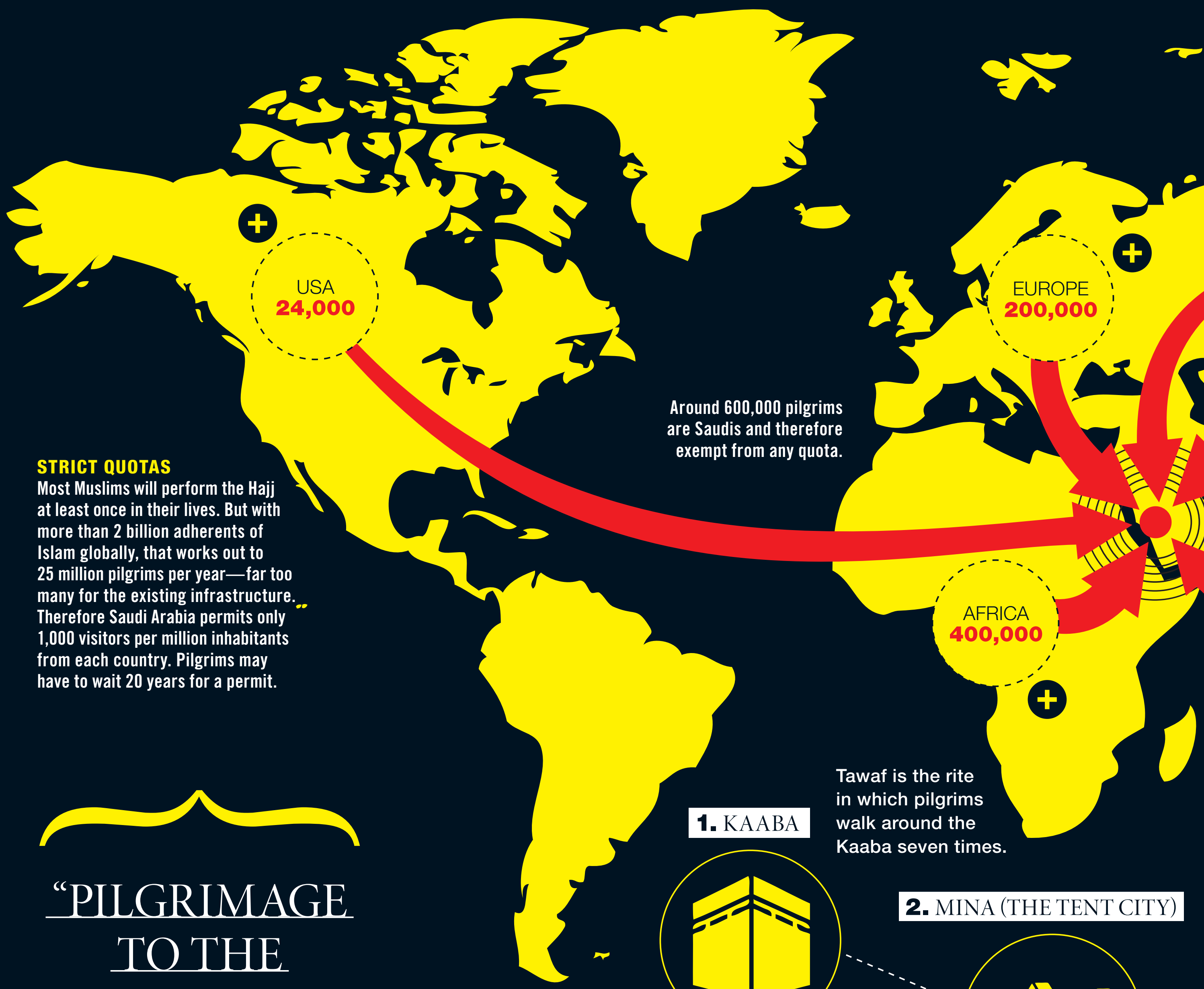
More than 2 million pilgrims from 168 nations with one goal: participating in the enormous Muslim pilgrimage, the Hajj, to the holy city of Mecca. What measures must be taken to protect such a vast gathering of people?

GLOBAL CONGREGATION
Almost 2.5 million pilgrims took part in the Hajj in 2019, and all but about 600,000 of them were foreign visitors. At the heart of the Great Mosque, the most important mosque in Islam, stands the Kaaba, a granite cube that is the religion’s most sacred site. Pilgrims are required to walk around it seven times.

DO YOU MANAGE
OWD?

SYMBOL OF POWER
As the custodian of the Hajj, Saudi Arabia enjoys tremendous power in the Muslim world but also assumes a tremendous logistical responsibility. The building in the foreground is a skyscraper hotel, the Makkah Royal Clock Tower Hotel; with 120 floors, it's one of the world's tallest buildings. It bears the Saudi coat of arms at the center of each clock face.

THE JOURNEY TO MECCA



Around 600,000 pilgrims are Saudis and therefore exempt from any quota.

STRICT QUOTAS
Most Muslims will perform the Hajj at least once in their lives. But with more than 2 billion adherents of Islam globally, that works out to 25 million pilgrims per year—far too many for the existing infrastructure. Therefore Saudi Arabia permits only 1,000 visitors per million inhabitants from each country. Pilgrims may have to wait 20 years for a permit.

> “PILGRIMAGE TO THE HOUSE IS A DUTY OWED TO ALLAH BY ALL.”
>
> **QURAN 3:97**

HIGHLY RITUALIZED
The date of the Hajj is fixed, always starting on the 8th day of Dhu al-Hijjah (the last month of the Islamic year) and ending on the 12th day. As pilgrims near Mecca, they don their ihram garments, which are made of two white seamless sheets that are wrapped around the body. After entering Mecca, the pilgrims walk seven times around the sacred shrine, the Kaaba, at the center of the Great Mosque, which covers 99 acres and can hold about 800,000 worshippers.

1. KAABA

Tawaf is the rite in which pilgrims walk around the Kaaba seven times.

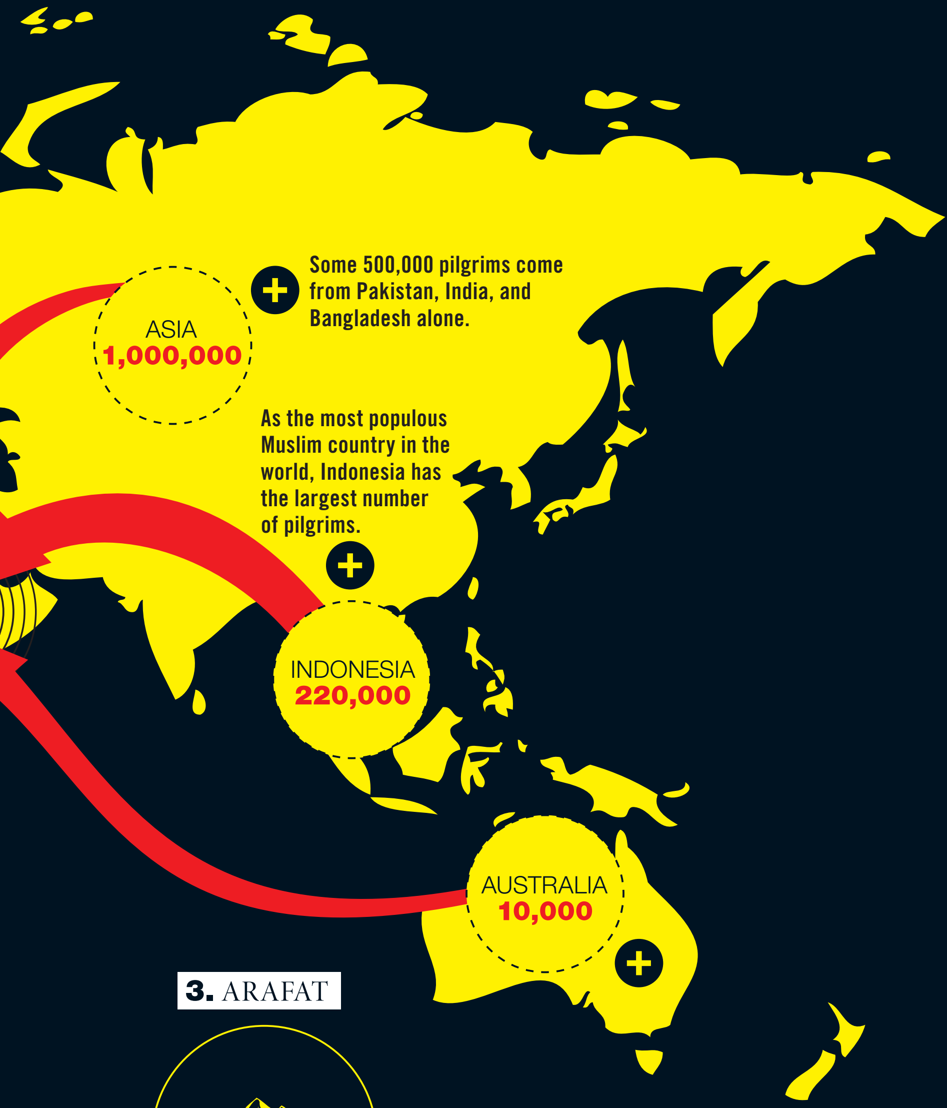
2. MINA (THE TENT CITY)

Another Tawaf that’s followed by a return to Mina and another stoning.

6. FAREWELL TAWAF

7. EID AL-ADHA

This sacrificial feast lasts four days and honors Abraham’s willingness to sacrifice his son Isaac. Around 50 animals are slaughtered per 100 pilgrims.



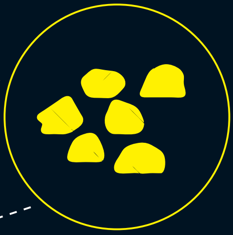
Some 500,000 pilgrims come from Pakistan, India, and Bangladesh alone.

As the most populous Muslim country in the world, Indonesia has the largest number of pilgrims.

3. ARAFAT

Pilgrims spend the next day on the Hill of Arafat, praying to Allah to forgive their sins.

4. MUZDALIFA



In this open level area pilgrims collect their pebbles for the Stoning of the Devil.

5. JAMARAT

On the Jamarat Bridge in Mina the pilgrims throw stones at three pillars that symbolize the devil.

UP TO
3.2 MILLION
PILGRIMS

168
NATIONS

64.3%
MALE

35.7%
FEMALE

HOW MUCH MONEY IS GENERATED BY **ONE VERSE OF THE QURAN**?

Mecca thrives on faith: The more than 2 million annual Muslim pilgrims add an estimated $12 billion to Saudi Arabia's GDP each year. Non-Muslims are not allowed to visit or even travel through Mecca. The airport of the nearby port city of Jeddah has a dedicated Hajj Terminal that can handle 80,000 travelers at a time. Visas for the Hajj or Umrah (a lesser pilgrimage that can be performed at any time) allow travel only to the cities of Jeddah, Mecca, Medina, and the routes between them. The local inhabitants of Mecca serve as guides for specific groups of pilgrims, depending on where they come from: There are guides for South Asians, Southeast Asians, African-Arabs, European denizens (including Turks), North Americans, and Iranians, respectively. Hajj package tours from the U.S. cost between $5,000 and $12,000, though it is possible to spend far more—and it all stems from a verse written in the Quran 1,400 years ago.

> “ONE PRAYER IN THIS PLACE IS BETTER THAN A HUNDRED THOUSAND PRAYERS OFFERED IN ANY OTHER MOSQUE.”
>
> **IBN TAYMIYYAH (1263–1328)**

HOW DO YOU HANDLE **2 MILLION PEOPLE** IN ONE WEEK?

Only 100 years ago, 50,000 pilgrims a year went on the Hajj; now the figure is more than 2 million—and it’s still rising. Saudi Arabia is doing what it can to make the pilgrimage ever more accessible. By only pointing at the Kaaba rather than kissing it, for example, pilgrims can complete that ritual at a rate of 250,000 people per hour. And since 2016 Saudi Arabia has been issuing electronic bracelets that provide information to worshippers but also contain the pilgrim’s personal information to help authorities with crowd control and providing personalized care. Mecca also has a Metro connecting the city to holy sites in Mina and Arafat. In operation only during the Hajj, it transports more than half a million passengers in an eight-hour period. Another bottleneck was removed in 2018 with the opening of the Haramain High Speed Rail system that links Mecca to Medina via the airport in Jeddah. Traveling at 186 miles per hour, the train makes the journey in 2 hours instead of the 10 the road journey can take during the Hajj.

214

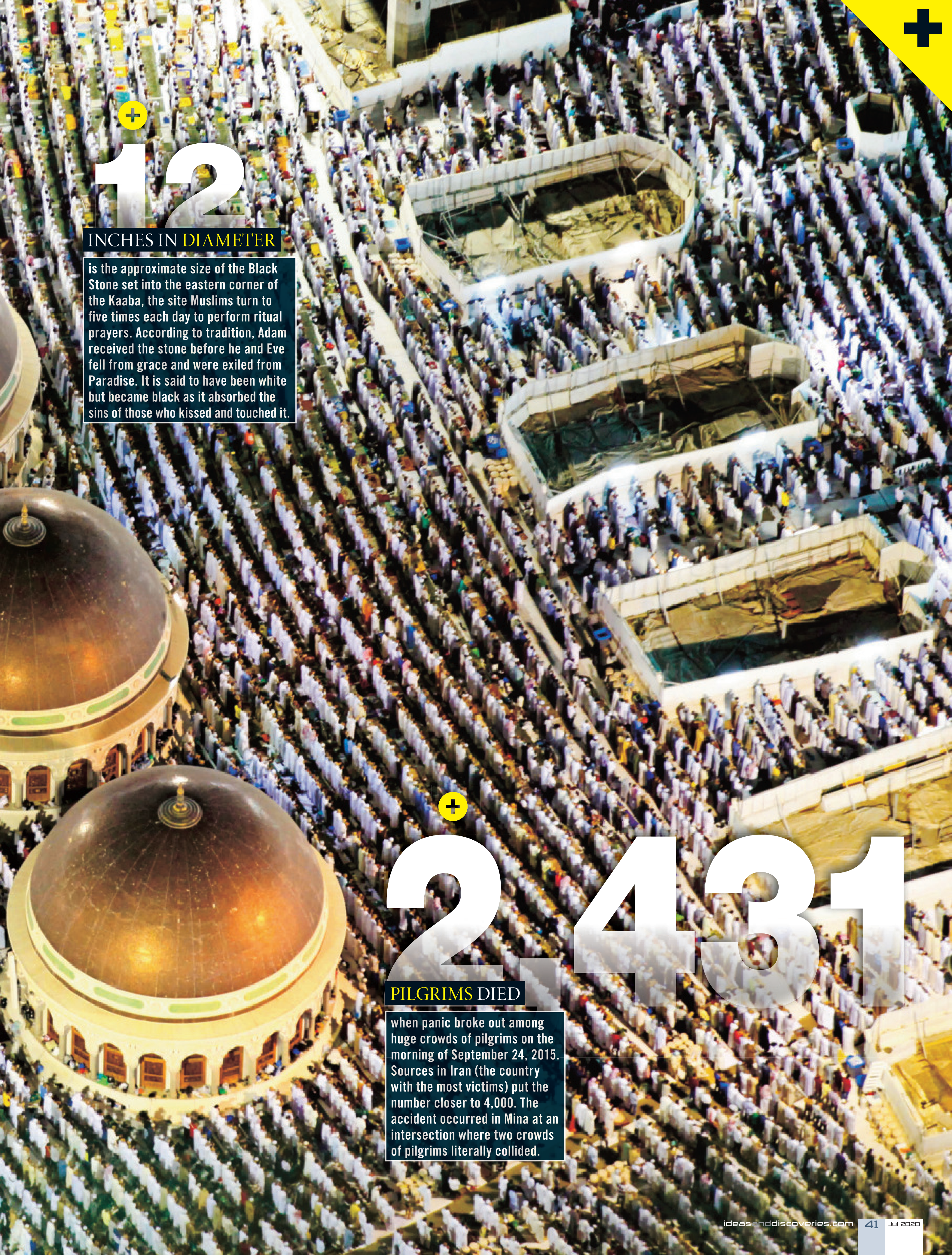
SQUARE MILES

is the size of the exclusion zone around Mecca. No non-Muslim is permitted to visit or even travel through the holy city. This restriction is designed to preserve the sanctity of the city and ensure a place of peace and refuge for believers.

820,000

WORSHIPERS

is the capacity of the world’s largest mosque, the Great Mosque of Mecca—seven times greater than the world’s biggest stadium in North Korea. This photo shows a detail of the roof during the holy month of Ramadan in 2017. Work to expand the mosque to hold 2.5 million worshipers came to a halt on September 11, 2015, when a building crane collapsed, killing more than 100 people.



12

INCHES IN DIAMETER

is the approximate size of the Black Stone set into the eastern corner of the Kaaba, the site Muslims turn to five times each day to perform ritual prayers. According to tradition, Adam received the stone before he and Eve fell from grace and were exiled from Paradise. It is said to have been white but became black as it absorbed the sins of those who kissed and touched it.

2,431

PILGRIMS DIED

when panic broke out among huge crowds of pilgrims on the morning of September 24, 2015. Sources in Iran (the country with the most victims) put the number closer to 4,000. The accident occurred in Mina at an intersection where two crowds of pilgrims literally collided.

WHO GUARDS THE HAJJ?

When it comes to protecting the safety and security of pilgrims, the royal House of Saud depends on a special forces unit known as the “Black Leopards.” Highly motivated and well equipped, they are positioned at the entrances to sacred sites and are trained to respond to terrorist attacks and other emergencies. Established in 2012, the Black Leopards report directly to the Head of Public Security in the Ministry of Interior.

110

BILLION DOLLARS

was the sum of arms sales to Saudi Arabia announced by President Trump in May of 2017. “This figure is vastly inflated,” says Naval War College professor Jonathan Caverley, who puts the figure closer to $20 billion. The Saudis spend around twice as much on arms as Russia, which has a population some four times greater.

8.8

PERCENT

of GDP was Saudi Arabia’s expenditure on the military in 2018. That’s more than twice as much as second- and third-place Israel and Russia, respectively, and makes Saudi Arabia one of the world’s most militarized nations. By way of comparison, the U.S. spends 3.2% of GDP and Canada only 1.3% of GDP on the military.

478,000

SOLDIERS

actively serve in the Saudi Arabian Armed Forces. In addition, there are 325,000 reserve personnel. The entirely separate Saudi Arabian National Guard has another 153,000 troops that are not under the control of the Minister of Defense. Composed of elements loyal to the House of Saud, these forces protect the royal family as well as the holy sites of Mecca and Medina.

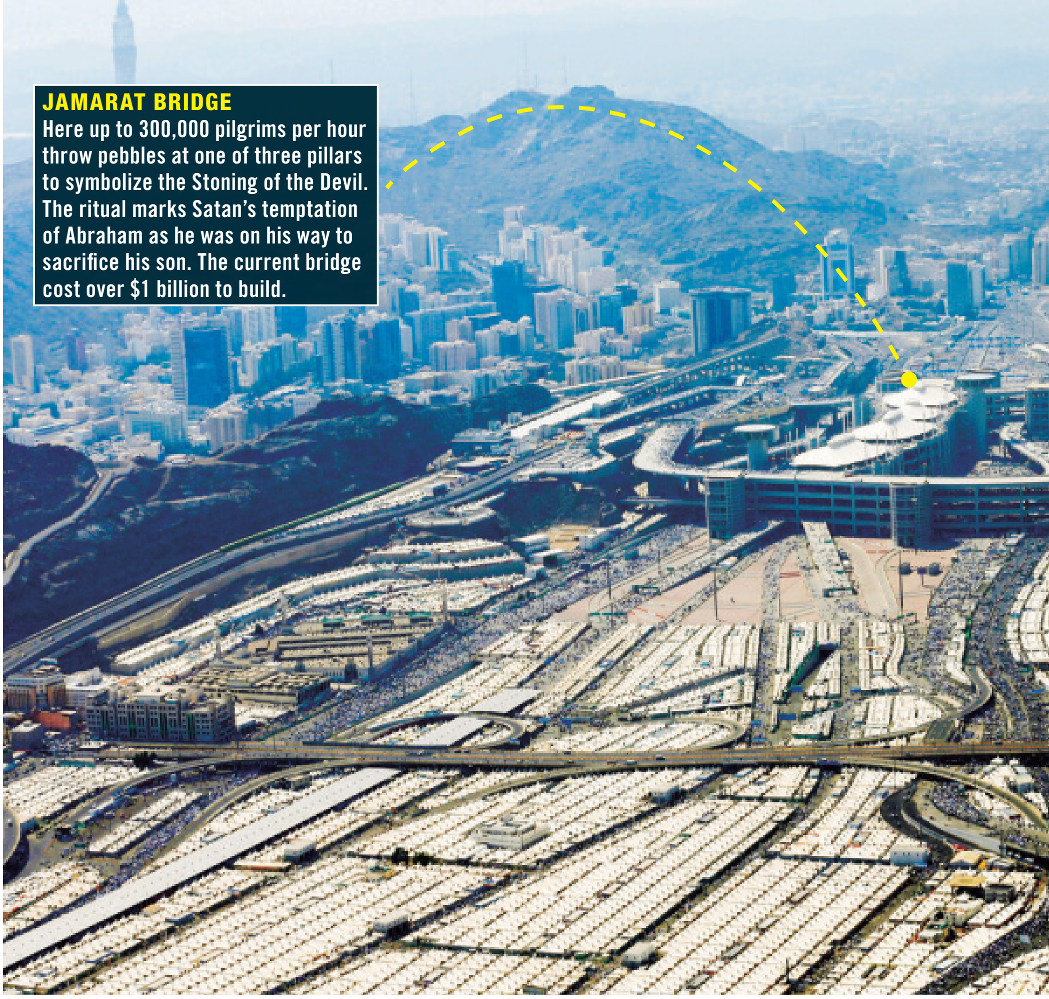
3,000

ANTI-TERROR SOLDIERS

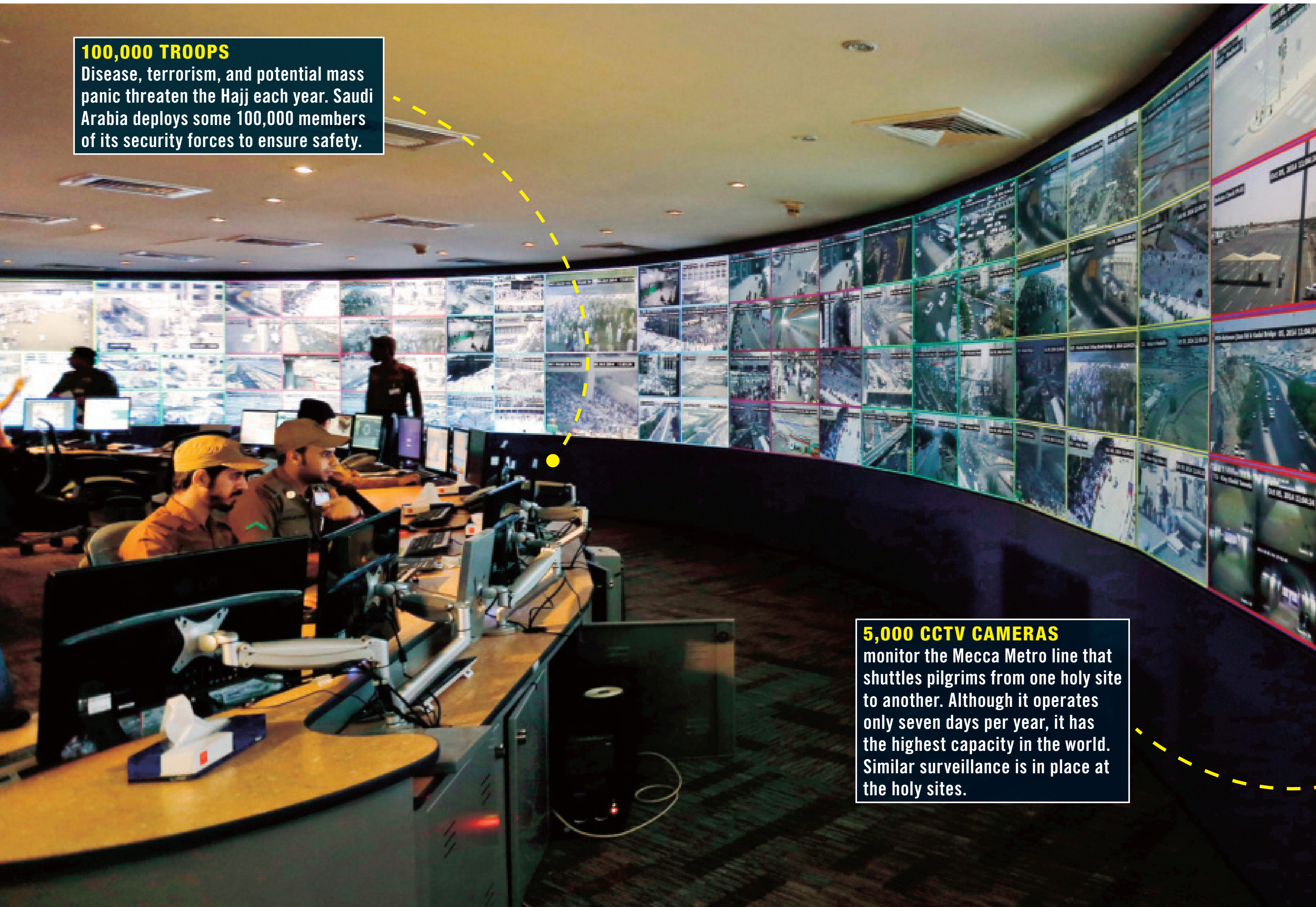
protect the Saudi capital, Riyadh. In this photo taken in September of 2015, Saudi Special Security Forces are seen training for an attack by terrorists at the Hajj in Mecca. Later in that year the Saudis announced a 34-country Islamic alliance to combat terrorism.

WHERE IS THE **WORLD'S BIGGEST GHOST TOWN**?

Arriving pilgrims spend their first night in the tent city of Mina, which can accommodate around 3 million people in more than 100,000 air-conditioned tents. From there they make their way the next day to Mount Arafat, where they pray to Allah to forgive their sins. The white tents measure 26 feet on each side and are made of Teflon-coated fiberglass to be fire-resistant. Pilgrims originally brought their own tents, which they dismantled and took home with them after the Hajj. In the 1990s the Saudi government erected cotton tents, but after a massive fire killed nearly 350 pilgrims in 1997, the tent city was rebuilt with the fire-resistant tents. During the rest of the year the site is deserted, making it the world's biggest ghost town.

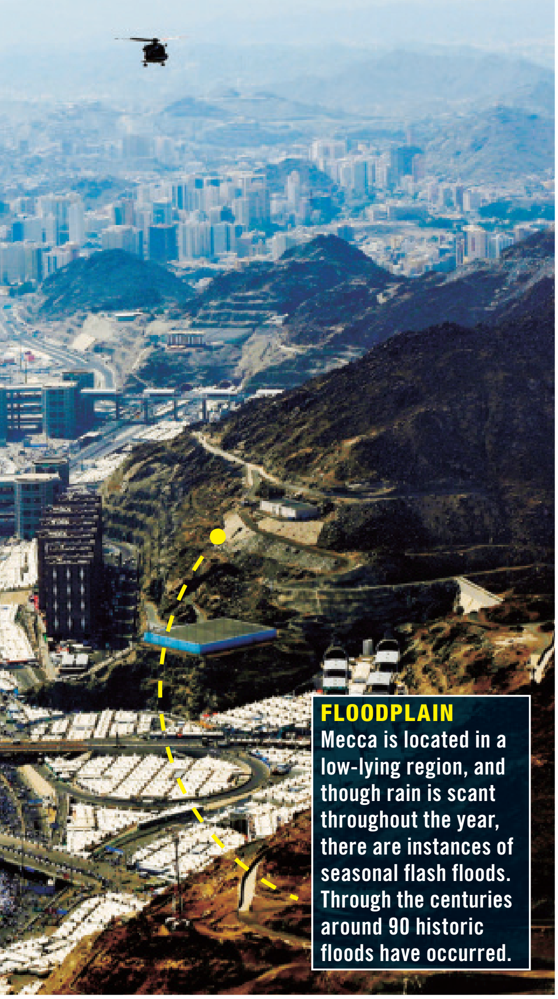


JAMARAT BRIDGE
Here up to 300,000 pilgrims per hour throw pebbles at one of three pillars to symbolize the Stoning of the Devil. The ritual marks Satan's temptation of Abraham as he was on his way to sacrifice his son. The current bridge cost over $1 billion to build.



100,000 TROOPS
Disease, terrorism, and potential mass panic threaten the Hajj each year. Saudi Arabia deploys some 100,000 members of its security forces to ensure safety.

5,000 CCTV CAMERAS
monitor the Mecca Metro line that shuttles pilgrims from one holy site to another. Although it operates only seven days per year, it has the highest capacity in the world. Similar surveillance is in place at the holy sites.



FLOODPLAIN
Mecca is located in a low-lying region, and though rain is scant throughout the year, there are instances of seasonal flash floods. Through the centuries around 90 historic floods have occurred.

His day has finally come: Eko, a Muslim from Indonesia, had been waiting for it for 20 years. In eager anticipation, he turns his gaze once again toward Mecca, holy city of Islam and home to the Kaaba—the House of Allah. Along with the profession of faith, prayer, almsgiving, and fasting, the Hajj is one of the Five Pillars of Islam, and now Eko has secured permission to undertake this great pilgrimage…

Eko waited two decades for Saudi authorities to grant him a permit to make the Hajj. That's how long it can take if you come from Indonesia. And as he finally begins his journey, he is the only one from his village to do so in that year. But in all, some 200,000 faithful Indonesians are making their way to Saudi Arabia on the distant Persian Gulf, where they'll be joined by about 2 million other pilgrims from 167 other nations. With this travel they will temporarily more than double the population of Mecca, Islam's holiest city. The Hajj also unites the pilgrims with those they leave behind at home because the entire Islamic world—more than 2 billion strong—joins in celebrating the last day of the Hajj.

A WAR ON SEVERAL FRONTS

The Hajj is a celebration of peace—but the preparations that precede it resemble those made for a foreign invasion by an enormous army. The Kingdom of Saudi Arabia has its own Ministry of Hajj that works 365 days a year to aid and protect the pilgrims. Some 75,000 pilgrims each year come from Iran, the largest Islamic state on the Persian Gulf—and also the archnemesis of the Saudis. There's also a major problem with illegal immigrants who are attracted by Saudi Arabia's oil-rich economy. Unrest is another constant threat: A crowd of more than 2 million pilgrims is difficult to control in the best of times, and there have been instances of mass panic among the faithful. Close to 2,500 pilgrims died in such an incident in 2015, and some sources say the death toll was far higher. More recently the Hajj has been threatened by major outbreaks of disease. In July of 2019 the Saudis banned pilgrims from the Democratic Republic of the Congo in order to keep the Ebola virus from being introduced to the Hajj. This February travel was blocked to the holy sites because of the growing incidence of COVID-19, and it was unclear as this issue went to press how the coronavirus would affect this year's Hajj. But disease is not a new threat: In the year 632 an outbreak of malaria was recorded, and in 1821 cholera claimed the lives of an estimated 20,000 pilgrims. The kingdom prepared for an outbreak of another coronavirus, MERS, in 2012, but the number of cases remained mercifully low. Terrorists have also targeted Mecca in the past: In 2017 security forces in the holy city foiled a bomber who blew himself up near the Great Mosque. A year earlier there were three suicide blasts in one day in Medina, Jeddah, and the city of Al-Qatif, which is on the Persian Gulf.

None of the dangers really troubles Eko, who is far more concerned with returning home to Indonesia once he has fulfilled his vital duty to Allah by completing the Hajj and thus earning the respected title of Hajji.

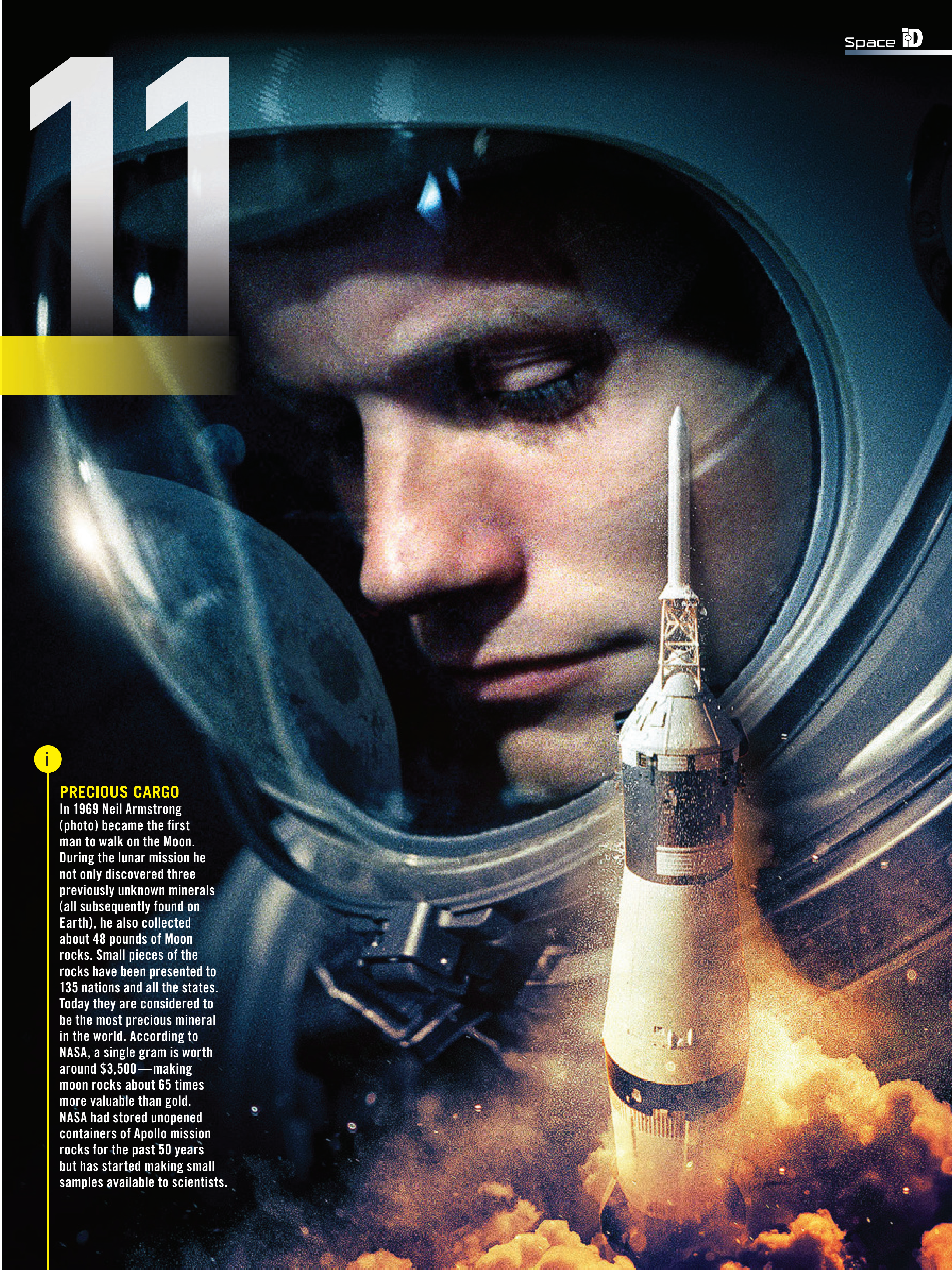
PHOTOS: Reuters (4); Getty Images.
ILLUSTRATION: wdw-Grafik.

APOLLO

HUMANITY'S GREATEST JOURNEY

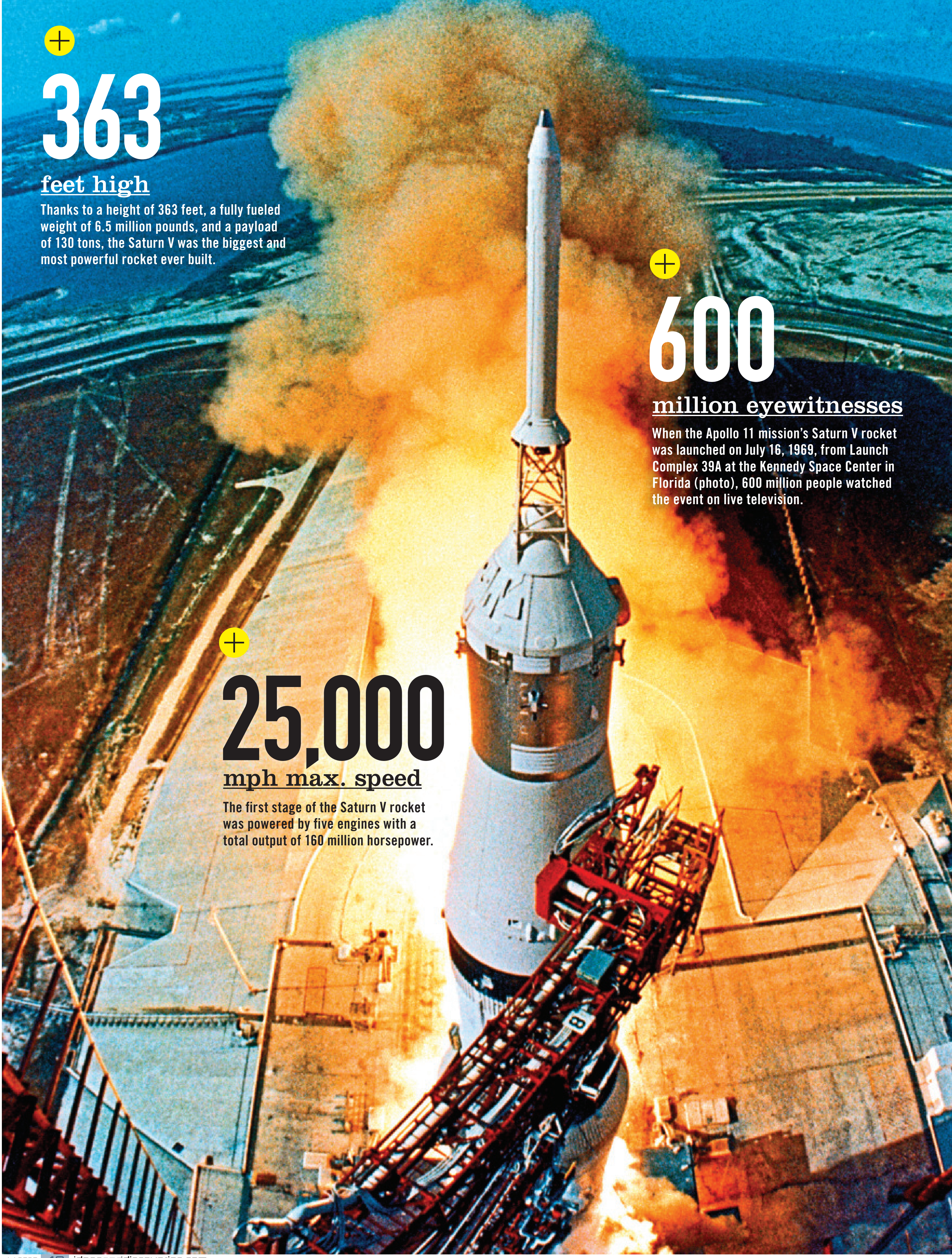
On July 20, 1969, Neil Armstrong became the first man to set foot on the Moon, making him an instant legend. His success was not only the result of his superb flying skills and the genius of NASA engineers—some of it can be chalked up to chance. Today we know that when the Saturn V rocket took off from the Kennedy Space Center four days earlier, not even NASA was convinced that the mission would be successful…

11



PRECIOUS CARGO

In 1969 Neil Armstrong (photo) became the first man to walk on the Moon. During the lunar mission he not only discovered three previously unknown minerals (all subsequently found on Earth), he also collected about 48 pounds of Moon rocks. Small pieces of the rocks have been presented to 135 nations and all the states. Today they are considered to be the most precious mineral in the world. According to NASA, a single gram is worth around $3,500—making moon rocks about 65 times more valuable than gold. NASA had stored unopened containers of Apollo mission rocks for the past 50 years but has started making small samples available to scientists.



363

feet high

Thanks to a height of 363 feet, a fully fueled weight of 6.5 million pounds, and a payload of 130 tons, the Saturn V was the biggest and most powerful rocket ever built.

600

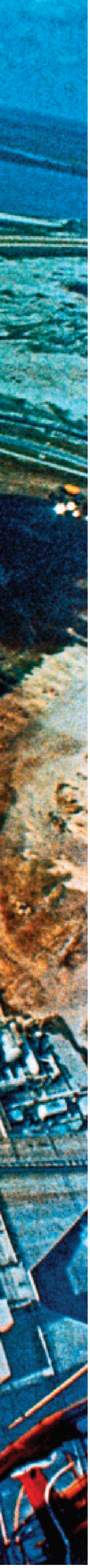
million eyewitnesses

When the Apollo 11 mission's Saturn V rocket was launched on July 16, 1969, from Launch Complex 39A at the Kennedy Space Center in Florida (photo), 600 million people watched the event on live television.

25,000

mph max. speed

The first stage of the Saturn V rocket was powered by five engines with a total output of 160 million horsepower.



“Ten minutes to landing,” announces Neil Armstrong as the Apollo 11 Lunar Module *Eagle* approaches the Moon at an altitude of 50,000 feet. Then he starts the *Eagle*’s engine. Sitting next to the 38-year-old flight commander is copilot Edwin “Buzz” Aldrin, who begins the countdown—announcing *Eagle*’s speed, course, and distance from the Moon. Until now everything had been going according to plan. But then there is a problem…

Checking the data from the Apollo Guidance Computer, Armstrong is shocked to discover that the lunar module is running 2 seconds ahead of schedule. The discrepancy is about 3,000 feet—the computer isn’t aware of it. Armstrong doesn’t hesitate. The experienced test pilot takes radical action, turning off the flight computer, ignoring Aldrin’s quizzical look, and reaching for the control stick. At this point *Eagle* is only around 1,000 feet above the surface of the Moon, and its planned landing zone is still nearly 4 miles away due to the discrepancy. It’s too late to break off the landing. “Fuel for 90 seconds,” reports Aldrin. From aboard the mothership, fellow astronaut Michael Collins asks if he should return home if the landing fails and the control room back on Earth gets ready to cut the live television transmission. Then Armstrong sets the lunar module down so gently that Aldrin doesn’t even notice the impact. There’s enough fuel remaining for just 10 seconds.

WHAT NASA WOULD RATHER NOT TALK ABOUT

Armstrong earned his student pilot’s license at age 16. “He was an artist,” says Armstrong biographer Andrew Smith. “Neil was able to control a 20-ton machine flying at Mach 1.5 with all the delicacy and the grace of a painter applying his brush.” The young pilot first rose to prominence during the Korean War when one of the wings of his jet was torn off by a booby trap, but he managed to eject himself and live through the landing. Nevertheless, Armstrong was not NASA’s first choice for the Apollo 11 mission. It was a well-kept secret, but there were five other astronauts ahead of him on the list. Two of them had died during the tragic Apollo 1 accident while the others were either sick at a critical moment or had fallen out of favor with the space agency. In the end, it was in no small part a coincidence that Neil Armstrong was chosen to be the first man to set foot on the Moon.

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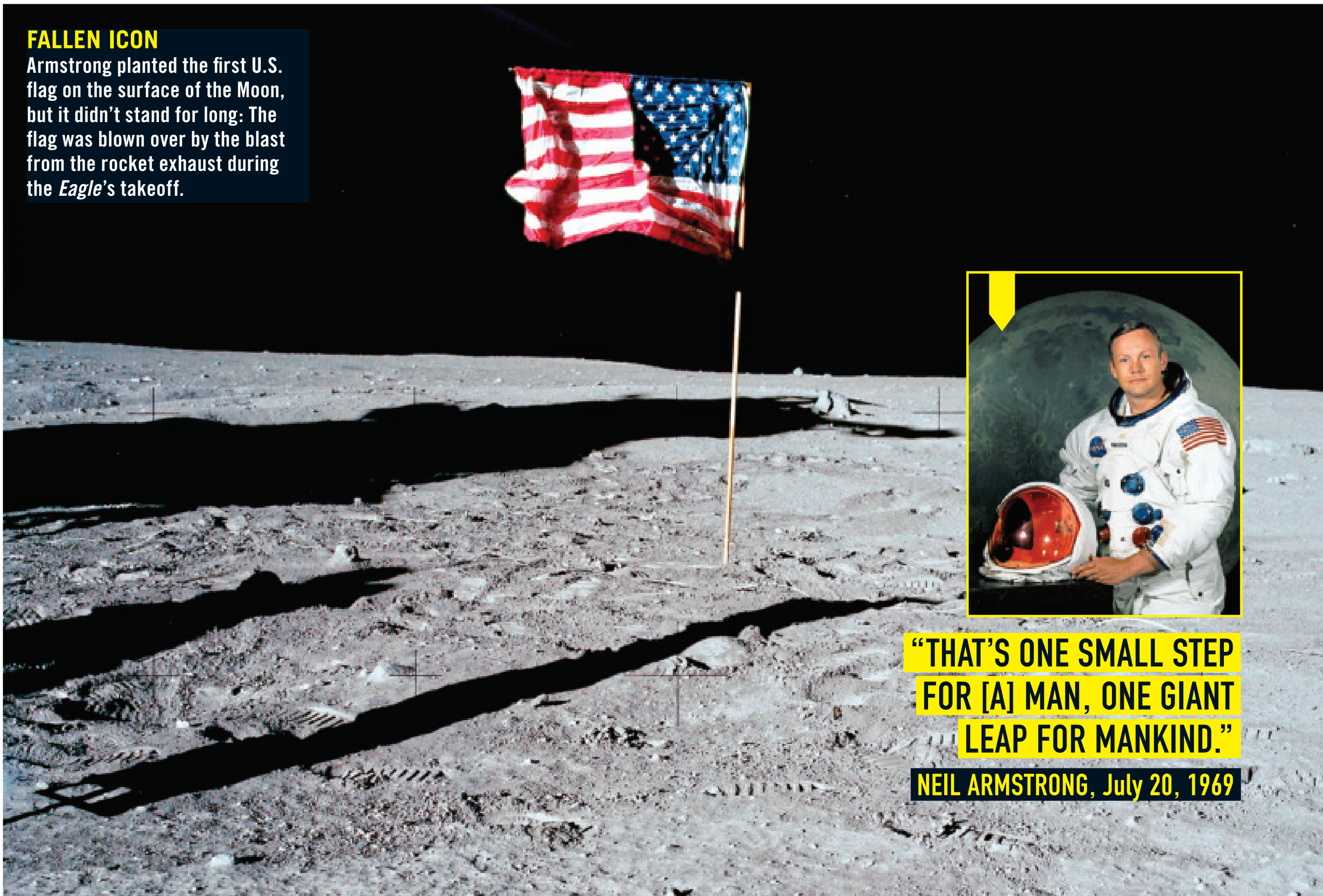


FALLEN ICON
Armstrong planted the first U.S. flag on the surface of the Moon, but it didn’t stand for long: The flag was blown over by the blast from the rocket exhaust during the *Eagle*’s takeoff.

“THAT’S ONE SMALL STEP FOR [A] MAN, ONE GIANT LEAP FOR MANKIND.”
NEIL ARMSTRONG, July 20, 1969

"THE FIRST MAN ON THE MOON WAS LATE BECAUSE HE HAD TO STOW THE DISHES AFTER DINNER."

What NASA would rather not talk about, even now, are the odds against success. In his account of the Apollo 11 mission, author Normal Mailer had stated that he "hardly knew whether the space program was the noblest expression of the twentieth century or the quintessential statement of our fundamental insanity." The flight computer built to control the Moon landing had only a small fraction of the computing power of a modern washing machine. And so when Neil Armstrong boarded the Apollo 11 spacecraft mounted on a Saturn V rocket (which had taken its first test flight just 20 months earlier), even the most optimistic NASA engineers put the likelihood of a successful return to Earth at less than 50%. The greatest risk was posed by technology that was never fully tested. In a later study NASA determined some 6,000 parts were installed in the Space Shuttle Columbia without absolute certainty that they worked. The space program was a daring enterprise from the start.

LIFE-SAVING FELT PEN

"The *Eagle* has landed." This was the phrase Armstrong spoke to announce the arrival: Two people successfully landed on the lunar surface. But they did not immediately exit the vehicle, and back on Earth millions of viewers wondered why. The explanation had long been kept secret because it was rather embarrassing: housekeeping! According to NASA's Mission Report, "There were checklists, food packets, monoculars, and other miscellaneous items that interfered with an orderly preparation." Author Andrew Smith says: "Armstrong was late because stowing the dishes after dinner was never part of the practice routine."

The list of things that went wrong sounds absurd today. When the time came to fly back to the Apollo 11 craft, Armstrong discovered that a switch for activating the ascent engine had broken off. "Luckily, a felt-tipped pen fit into the slot," Aldrin later recalled. The engine started.

DRY RUN
Neil Armstrong tested out his equipment on Earth before embarking on the historic mission.

There are many other sensitive or long-forgotten anecdotes. Less-often mentioned is the third man on the mission, Michael Collins. Remaining in the command module during the landing, not only did he not step onto the Moon, he was also one of the few people in the Western world who did not have an opportunity to view the landing. He couldn't see the Moon—not through a window or on a monitor. He is said to have repeatedly asked Mission Control what was going on down below. And then there is the matter of pay: The annual salary of the three Apollo 11 astronauts ranged from $27,401 for Armstrong to $17,147 for Collins. Based on his salary and the 40-hour workweek, that means Armstrong was paid about $33 for his time on the moon—$230 in today's dollars. The astronauts would later joke that they were partly to blame for the Apollo program having cost $25 billion.

THE APOLLO 11 CREW
Commander Neil Armstrong, command module pilot Michael Collins, and lunar module pilot Buzz Aldrin (from left to right).

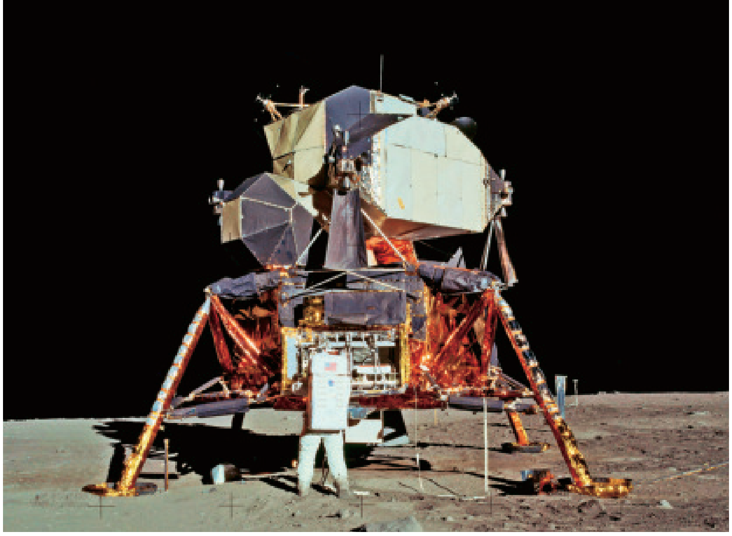
PHOTOS: NASA (6); Verleih.

SMARTER IN **60 SECONDS**

Space Travel

Did NASA have a **base** on the **Moon**?

Touch down, take pictures, collect rocks, and return home: That's the way many of us imagine a Moon landing. But the astronauts on the final NASA Moon mission (Apollo 17) stayed for three days: Eugene Cernan and Harrison Schmitt camped out in their lunar module while Ronald Evans remained in lunar orbit in the command module. During NASA's six lunar landing missions, a total of 12 astronauts walked on the surface of the Moon, and 6 of them drove Lunar Roving Vehicles (LRV). Conditions in the lunar lander (shown here: the *Eagle*) were cramped and bright. But who could even think of a nap when visiting the Moon for the first time?



How many **cars** are **parked** on the **Moon**?

American flags, golf balls, a small golden olive branch, tools, a signed family photograph, the television camera that sent pictures of the first Moon landing back to Earth, other discarded equipment, bags of human feces, and three Lunar Roving Vehicles are among the objects left behind on the Moon. A team assigned to list all of the items identified more than 100 of them. The astronauts created what archeologists call a "toss zone"—the sort of junk pile that human civilizations have been making for millennia.

On their final three Apollo missions, U.S. astronauts used electric Lunar Roving Vehicles to get around the Moon.

Why can't you **burp** in **space**?

Swallowing air along with your food and drink is a fact of life and unavoidable, whether you're on the ground on Earth or somewhere out in space. On the ground, gravity sees to it that the food mixture slides down into your stomach and intestines, while ingested air is expelled through the esophagus. Without gravity, however, it all becomes a foamy mixture floating around in your stomach and a belch would allow the mixture to come forth instead of air. But swallowed air has to go somewhere. And that's why flatulence-inducing foods are shunned in space.

Who maintains **law and order** in **space**?

Anyone who thinks space is a lawless zone is greatly mistaken. The Outer Space Treaty, which took effect in 1967, is administered by the United Nations Office for Outer Space Affairs. The treaty has been ratified by more than 100 nations and is signed but not yet ratified by two dozen more. It specifies that space exploration is for the benefit of all countries. Nuclear weapons are prohibited in orbit and on celestial bodies. Use of the Moon or the planets must be for peaceful purposes, and each of the countries is responsible for its own space activities, whether conducted by governmental or private entities.

PHOTOS: Getty Images; NASA; Smithsonian Museum.

Whether we're talking about rivers, lakes, or streams, bodies of fresh water have received far less attention and research than our oceans. One of the many open questions: How many life-forms make fresh water their home? Now a new research method could finally answer this question.

HOW MUCH DNA IS THERE IN A DROP OF WATER?

SECRET CODES IN THE STREAM
A Swiss biologist has found a way to decipher the life codes in water. Soon the DNA fragments present in a single drop could reveal the biodiversity of an entire body of water.

AQUATIC FORENSICS
Biologist Florian Altermatt and his team of researchers at the University of Zurich analyzed the environmental DNA (eDNA) of a Swiss river, and the results are amazing.

You might assume that one of Europe's largest bodies of fresh water, the Alpine Lake Constance, has been thoroughly researched—but you'd be mistaken. With an area of more than 200 square miles, the lake bordering Austria, Germany, and Switzerland is the third-largest lake in Western Europe, but in many respects it remains a proverbial blank spot on the map, particularly when it comes to its biological diversity. While the specialist literature mentions around 800 various life-forms present in its 12 cubic miles (13.2 trillion gallons) of water, that's merely a rough estimate. No one can say for certain how many organisms there really are. Reason: Bodies of fresh water are living hot spots. Around 100,000 species are known to make their home in freshwater habitats, and many more are there just waiting to be discovered. Therefore it's not feasible to measure species diversity in a comprehensive and systematic manner. But now that is changing: Scientists at the Swiss Federal Institute of Aquatic Science and Technology have developed a method to determine exactly which life-forms reside in a body of water—and all it takes is a single drop…

A VIEW OF ANOTHER WORLD

Professor Florian Altermatt carefully places a few drops of pond water on a glass slide. As far as the naked eye can tell, there's nothing unusual about it. But, magnified 400 times under a microscope, the water is teeming with life that includes not just water fleas, rotifers, photosynthetic bacteria, and algae but also the genetic footprints of many other plants and animals.

Altermatt is a biologist and a DNA detective who sees a drop of water as a data medium that documents in meticulous detail all of the creatures that have lived in or near the pond from which the water sample came. This is possible because of the wide range of environmental DNA (eDNA) that the pond contains, which can be matched to a database to determine the species. Aquatic organisms are constantly shedding DNA into the water, via feces or skin particles, for example. And DNA from areas near the water gets washed into it as well. So by using special filters Altermatt isolates eDNA, identifies individual types, and compares them with databases to determine the species. His discovery could help prevent species loss and perhaps even guarantee the continued survival of the human race. >

Aquatic Observatory

A team at the Cooperative Institute for Great Lakes Research in Ann Arbor, Michigan, simulates the ecology of freshwater bodies in the lab. Their research shows that water quality is directly related to the biodiversity of the water. The general principle: The more species present in water, the higher its quality.

Numerous studies have now shown that biodiversity is directly connected with the quality of the most important resource of the 21st century: water.

WHEN WATER GOES BAD

In 2017, Germany's Federal Agency for Nature Conservation published a report that painted a rather gloomy picture of the future for the country's flora and fauna. Of the 71,500 species that were identified, about 30% were considered endangered and 5% had already become extinct. Species loss is also a great concern in the United States, where today more than 1,300 species are considered endangered or threatened. But U.S. scientists are trying to do something about it: At the University of Michigan, for instance, freshwater ecologist and director of the Cooperative Institute for Great Lakes Research Bradley Cardinale conducted a study on the relationship between biodiversity and the quality of water. He found biologically diverse streams are much better at removing pollutants than those with fewer lifeforms. Biologists have often cited the many benefits of biodiversity, such as controlling disease and pests and promoting production of fish, however Cardinale has shown that it also leads to improved water quality, and he has explained the pertinent mechanism. Noting that each species of algae in a body of water has a unique ability to remove a particular pollutant, he concluded the more species of algae that inhabit a given body of water, the more pollutants they can remove from it. The capability is important because pure water for drinking and for other human needs is among our greatest concerns in securing a healthy future. In this regard the method developed by biologist Florian Altermatt will be extremely useful. His water samples contain not only the DNA of aquatic organisms but also the DNA of those inhabiting the entire catchment area along a river or lake. If his method can be automated, it could provide data on the current health and development of biodiversity in a given area and aid efforts to prevent its further decline.

Researchers used to struggle with the fact that as a species became increasingly rare, it would become harder and harder to detect it. But now eDNA is turning things around. It's also opening up the possibility of detecting the presence of new invasive species before they get problematic. The kind of invasion scientists want to prevent is exemplified by killer shrimp.

ATTACK OF THE KILLER SHRIMP

Dikerogammarus villosus is not really a shrimp at all, but the tiny crustacean with the large destructive mouthparts has earned the name "killer shrimp" due to its vicious predatory behavior: It often kills its prey without eating it. Originally from the south of Russia, they have spread through Western Europe over the past 30 years and have now reached the British Isles, where scientists are concerned they are decreasing the fish populations and otherwise harming the health of fresh water. In Western Europe they are known to have driven numerous species to extinction, and there are fears they could eventually spread to America's Great Lakes. Scientists are already on the lookout there. Perhaps Altermatt's eDNA technology can help alert them by sounding an early alarm.

PHOTOS: Sean Gladwell, Yuichiro Chino, Elif Bayraktar (2), Sergii Trofymchuk, NNehring, David Spears FRPS ASIS FRMS, dfun—all /Getty Images; Austin Thomason/Michigan Photography/UoM; PR.

THE EAGLE HAS LANDED...

On July 20, 1969
Man Walked on the Moon

APOLLO 50 NEXT GIANT LEAP

Apollo 11 50th Anniversary

Masterpiece Stein

ONE SMALL STEP FOR MAN
APOLLO 11
50 Years
APOLLO 11
1969
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Our finest tribute, crafted of richly colored *Heirloom Porcelain®*

•

Hand-set sculpted medallion finished with 22K gold adorns the front

•

Custom metal topper and custom thumb rest recreate the lunar command module

•

Famed quote rings the neck

•

Mission date and logo appear just above the base

THE EAGLE HAS LANDED
Launch: July 16, 1969
Kennedy Space Center Launch Complex 39A
Landed on Moon: July 20, 1969
Landing Site:
Mare Tranquillitatis
(Sea of Tranquility) 0.67 N, 23.47 E
Time on Lunar Surface:
21 Hrs. 38 Min. 21 Sec.
Mission Duration:
195 Hrs. 18 Min. 35 Sec.
Returned to Earth: July 24, 1969

Reverse features information about the mission, a view of Earth from the Moon and the NASA logo

Impressive 10 inches high

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ONE SMALL STEP FOR MAN...

Was watched around the world as the heroic crew of Apollo 11 reached the surface of the moon and stepped into history. Now those who flew and those who supported them on Earth are given our finest tribute: The *Apollo 11 50 th Anniversary Masterpiece Stein*. Crafted of richly colored *Heirloom Porcelain®*, it's filled with design elements that commemorate the mission and the mighty space vessel that took them there and back again. The centerpiece, however, is the sculpted medallion celebrating the craft in all its stages that's embellished with 22K gold and hand-set on the front. A remarkably detailed zinc alloy lid shaped like the lunar command module gleams from the top. The thumb rest is shaped like the command/service module in flight and completes this remarkable, 32-ounce masterwork.

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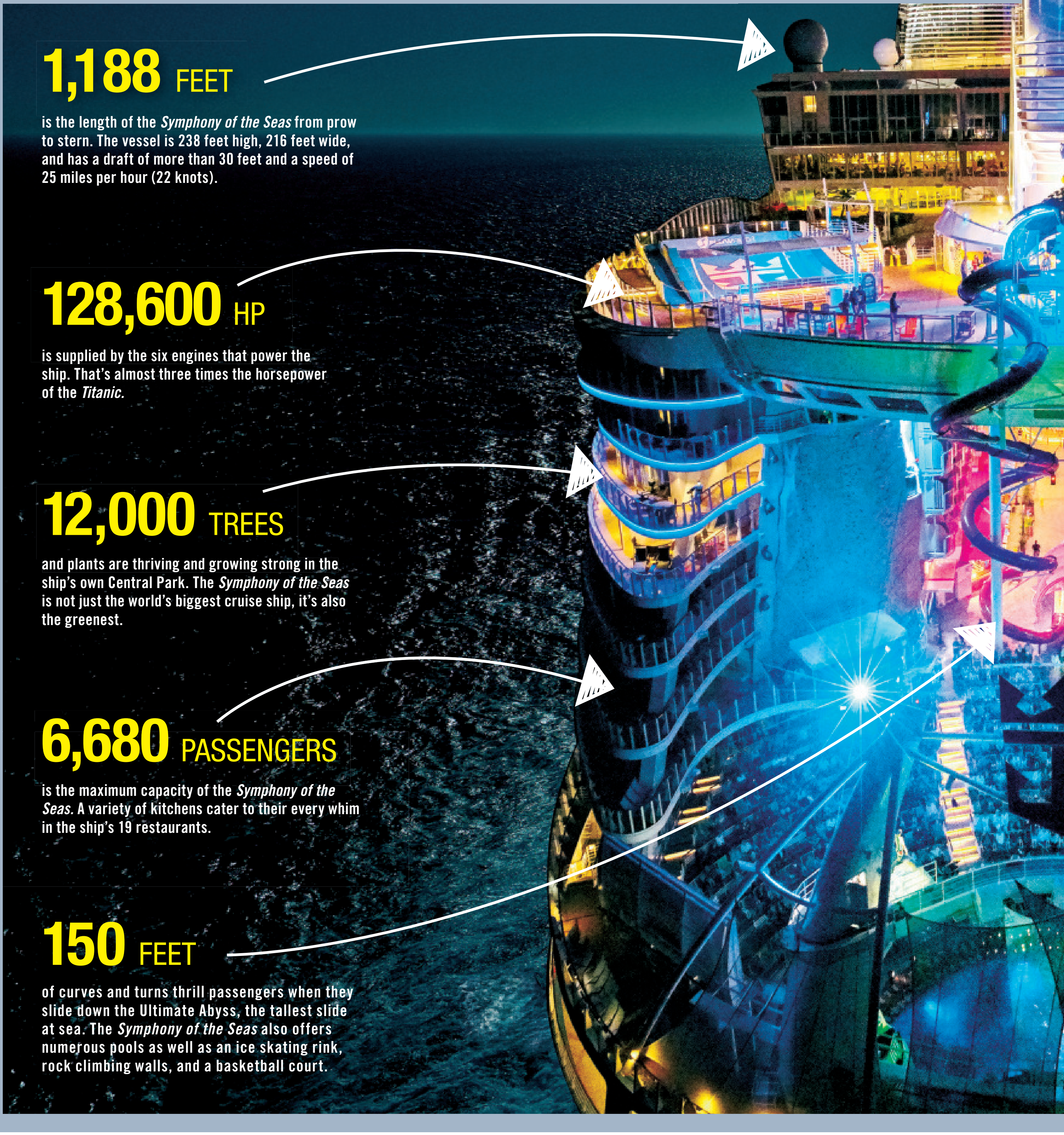
iD questions

Ask a simple question, get a simple answer? Think again! Scientists often have to work meticulously to come up with explanations for basic processes—and sometimes they inadvertently discover marvels that can change our perception of the world.



1,188 FEET

is the length of the *Symphony of the Seas* from prow to stern. The vessel is 238 feet high, 216 feet wide, and has a draft of more than 30 feet and a speed of 25 miles per hour (22 knots).

128,600 HP

is supplied by the six engines that power the ship. That's almost three times the horsepower of the *Titanic.*

12,000 TREES

and plants are thriving and growing strong in the ship's own Central Park. The *Symphony of the Seas* is not just the world's biggest cruise ship, it's also the greenest.

6,680 PASSENGERS

is the maximum capacity of the *Symphony of the Seas.* A variety of kitchens cater to their every whim in the ship's 19 restaurants.

150 FEET

of curves and turns thrill passengers when they slide down the Ultimate Abyss, the tallest slide at sea. The *Symphony of the Seas* also offers numerous pools as well as an ice skating rink, rock climbing walls, and a basketball court.

& answers

DO YOU HAVE A QUESTION FOR OUR TEAM OF EXPERTS?
Just send us an email!
questions@ideasanddiscoveries.com

HOW MUCH DOES A FLOATING CITY COST?

Cruise ship companies are building their vessels bigger and better, in competition with one another to own the biggest one of all. When the *Symphony of the Seas* went into service on March 31, 2018, it became the official queen: the biggest cruise ship in the world. Only a few tons heavier than its sister ship and previous record holder, the *Harmony of the Seas,* the *Symphony* fulfilled one of her purposes by keeping the record in the family. Such huge dimensions have their price, of course: The *Symphony of the Seas* was built at the Chantiers de l'Atlantique shipyard in Saint Nazaire, France, for a price of $1.35 billion. With a total length of 1,188 feet and 1 inch (14,257 inches), that works out to $94,690 per inch. By way of comparison, the ship's cost is equivalent to the price of 16 new Boeing 737-700 jetliners—or 10 times greater than the cost of Frank Gehry's Disney Concert Hall in Los Angeles. The word "ship" doesn't really do justice to the *Symphony of the Seas.* At times this floating city has almost 9,000 people on board (6,680 passengers and 2,200 crew), and it has the infrastructure to go with it. On the 15 decks accessible to the passengers and crew, the *Symphony* offers three childcare groups for kids ages 3 to 11, an onboard hospital, a park with 12,000 trees and plants, a mini golf course, two climbing walls, numerous swimming pools, outdoor movies, 19 restaurants, and a special GPS system for finding your way around the ship. One of its highlights is the Rising Tide Bar, a combination elevator and bar that ascends and descends between decks 5 and 8 and is the coolest way to travel between the ship's Central Park and the Royal Promenade while enjoying your favorite adult beverage. That's why there's an age restriction on the ride, which is definitely not for kids. To ride on the Rising Tide you have to be at least 21 for sailings from North America and 18 for cruises starting in the rest of the world.

WHY DO DOGS SOMETIMES SNIFF AIR THROUGH ONLY ONE OF THEIR NOSTRILS?

A dog's nose is a high-precision instrument equipped with up to 300 million olfactory receptors that are tasked with converting sensory input into electrical impulses. That gives dogs a sense of smell up to 100,000 times better than ours. A dog primarily uses its right nostril when it encounters a new scent. As in humans, the right nostril is linked to the right side of the brain, which researchers believe engages with novel information. When the dog becomes more familiar with the scent, the left nostril takes over.

STEREO SNIFFING
A dog processes input from the two sides of its nose separately. That's what gives it the ability to reliably track a scent.

WHAT'S THE COLDEST PLACE ON EARTH?

The lowest outdoor temperature ever recorded was –128.56°F, registered at Vostok Station in Antarctica on July 23, 1983. But now researchers have discovered a location that is even colder. Ted Scambos of the National Snow and Ice Data Center at the University of Colorado Boulder has identified several locations on the East Antarctic Plateau where the temperature drops down to –137°F. "This temperature seems about as low as it is possible to reach," says Scambos. The new record could last indefinitely due to global warming. Antarctica's continent-wide average temperature has risen by about 0.8°F every decade since the 1950s, and the Antarctic Peninsula has recently been setting new heat records.

A WORLD OF ICE
Just like the Arctic, Antarctica is rapidly losing ice (photo: ice cave within a glacier tongue). The melting in West Antarctica could result in 1 foot of sea level rise by 2100 and 10 feet in the next century.

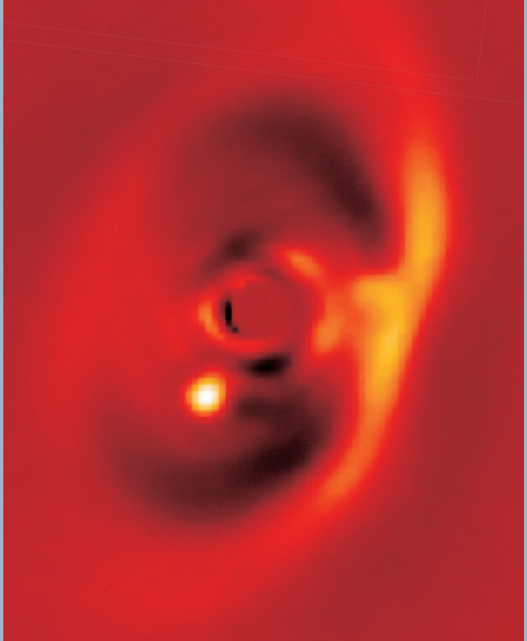
HOW DANGEROUS IS A NECKTIE?

While traditionally a feature of business attire, neckties can be risky. The authors of a new study have found that tie wearers received 7.5% less blood flow to the brain, and they termed wearing a tie "socially acceptable strangulation." Ties were found to be a risk factor for high blood pressure, headache, dizziness, and nausea as well as glaucoma and cataracts. A tie decreases the wearer's range of motion, generating muscle tension and increasing the risk of injury. And surgeons received a special warning: Infectious pathogens accumulate on their neckties.

Why does summer rain have a special fragrance?

Rain itself has no scent, but we're all familiar with the smell that fills the air after the first summer rain has fallen. This distinct scent has a name—petrichor—and it's caused by chemicals on the ground that are released by the rain and lifted into the air. Now MIT scientists have used a high-speed camera to see what process actually releases the smell when raindrops hit the ground. They found that the drops trap tiny bubbles that shoot up through the drops to create a fizz, carrying fragrant particles up into the air, much like the spray from an aerosol can. More particles are spread during a light or moderate rainfall than during a heavy downpour. Now the study authors want to know whether the particles can also spread bacteria and viruses and thus disease.

What does the birth of a planet look like?



This image might seem like an embryo in the uterus—and the comparison is not altogether so far-fetched—but what you are seeing here is the protoplanetary disk of the star PDS 70 and the new planet PDS 70b located around 370 light-years from Earth. The star is some 10 million years old and about the size of our Sun. The discovery of the nascent planet was made by a team of astronomers working in Japan and the United States. They suspect there may be more planets in the disk and are trying to locate them. Easier to detect around massive stars, the PDS 70 phenomenon is interesting because of possible parallels to our own solar system.

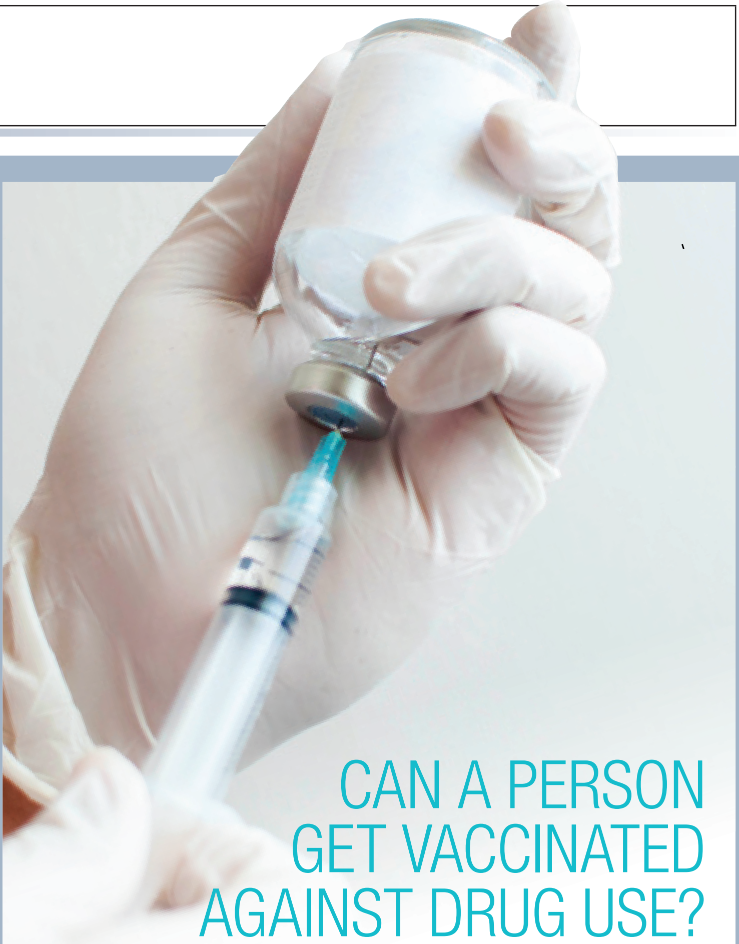
HOW FAST CAN A HELIC

No one will ever build a helicopter that flies from point A to B as fast as a fixed-wing jet. That's because a helicopter's speed is limited by the very complex aerodynamics of its rotor blades. While the average conventional helicopter flies at only around 160 mph, the tips of the rotors are moving much faster. When the copter is hovering, the speed of the blade tips depends on the length of the blade and the RPM of the rotor, and the speed of a blade tip can actually be faster than the speed of sound. Given such high speeds, the asymmetrical wind forces on the blades are a major problem when the copter is moving forward: On a moving copter, the blade turning toward the front at any given moment has a higher speed relative to the wind than the one that is turning toward the back. So far the maximum speed of a conventional helicopter has been about 180 mph, but Airbus's experimental RACER (Rapid and Cost-Effective Rotorcraft) can cruise at up to 250 mph and is expected to reduce the cost of flying a given distance by about 25%. Airbus hopes to begin production sometime later this year. The new high-speed copter will allow doctors and rescue workers, for example, to arrive at an accident scene much faster. Airbus has already demonstrated the viability of its design with the Eurocopter X3, which set a helicopter speed record in 2013, flying at 293 mph. The compound helicopter was able to climb at a rate of 5,500 feet per minute, taking less than 60 seconds to reach mile-high altitude.

OPTER FLY?

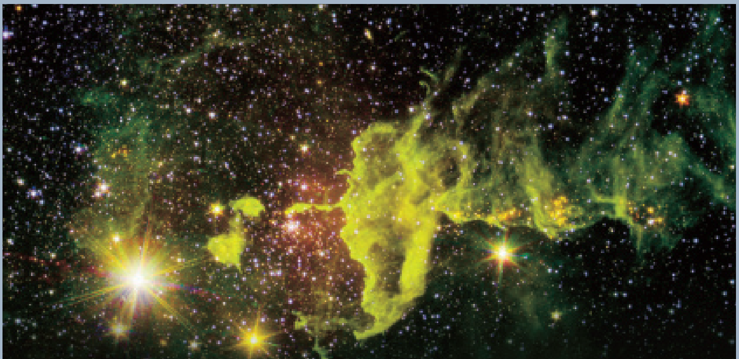
ENERGY EFFICIENT
The RACER's "box-wing" design features a double fixed wing for energy-efficient lift, lateral rotors to propel the aircraft, and a main rotor for vertical takeoff and landing.

SAFE AND QUIET
The RACER's lateral rotors are pointed toward the back to give passengers a quieter ride. They also eliminate the need for a tail rotor, which in a regular helicopter keeps the aircraft straight and prevents it from spinning in the opposite direction of the main rotor.



CAN A PERSON GET VACCINATED AGAINST DRUG USE?

The United States has a serious drug problem, fueled primarily by the millions of people who are addicted to opioids. A joint project of the Walter Reed Army Institute of Research and the National Institute on Drug Abuse is working on a vaccine to help addicts get healthy again. Vaccine testing can take many years, but given the current crisis, there are efforts to get quick approval for clinical trials of new vaccines that prompt the body to develop antibodies against heroin as well as other opioids. These essentially trick the body into rejecting the drugs when a user injects or ingests them again and thus prevent the substances from crossing the blood-brain barrier and having a psychoactive effect.



Do stars have a pulse?

Our home star, the Sun, has a solar cycle of about 11 years, during which sunspots increase or decline, resulting in a slight change of brightness (about 0.1%). But astronomers have detected stars that actually pulsate and do so on a wide range of time scales, ranging from less than a minute (white dwarfs) to several years (giant red stars). Now they have identified a small number of blue stars that pulsate during a period between 40 and 70 minutes, a cycle they say was unknown until now.

WHO CLEANS THESE ROADS?

A shamal is a hot dry north-westerly wind that gives rise to huge sandstorms in Iraq and the other states of the Arabian Peninsula, mostly during summer. The wind speed can exceed 40 mph, and the resulting sand and dust storms can seriously impact transportation and health, leading to covered roads, decreased visibility, the cancellation of flights, and respiratory problems. The summer shamal winds crop up from May to August and reach peak speeds at noon each day. A shamal can last between three and five days, and all the drifts and dunes that build up on the roads can be expensive to remove. Tourist locations may have to renew beaches when their sand has been swept away. In Dubai, when the winds finally die down an army of hundreds of workers struggles to clear the roads. Road sweepers handle up to 600,000 tons of sand per day.

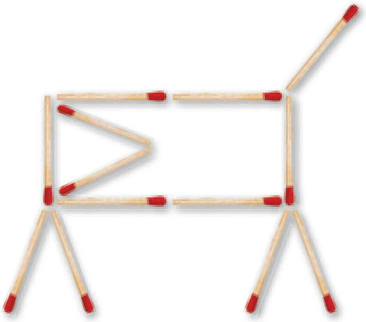
Brainteaser

The solution will appear in the next issue, on stands July 10, 2020.

When building a garden pond, Mark has to do some math: He knows that the water lilies planted in the pond double the area of their leaves on the water every day. And he also knows that in 48 days' time the garden pond will be completely covered with water lilies. How long will it take until half of the water is covered with lily pads?

Solution from the May 2020 issue:

A matchstick cat had originally been shown walking toward the left side of the page and looking to the left. Here in the image at right you can see which two matchsticks would have to be moved so the cat looks toward the right side of the page instead of the left.



WHY ARE CHIMPANZEES SO MUCH STRONGER THAN WE ARE?

Our hairy relatives may be smaller, but relative to their body mass, they are 1.5 times stronger than humans. Researchers at the University of Arizona College of Medicine think they know why. The difference lies in the ratio of slow-twitch to fast-twitch fibers in the muscles of the two species. In human muscles the ratio is 70/30 while in chimps the ratio is 33/66. That makes a chimp's muscles 1.35 times more powerful than those of a human. The scientists tested a wide range of mammals and found that the only one besides us with such a high percentage of slow-twitch fibers is a lethargic little primate called the slow loris. Fast-twitch fibers are an advantage in tests of strength, such as heavy lifting or climbing a tree. Slow-twitch fibers, on the other hand, make humans better suited to endeavors that involve endurance, like long-distance running.

- Decisive advantage: The human brain is about three times bigger than that of a chimpanzee.
- Researchers had long thought chimpanzees were five times stronger than humans are—but they were wrong.
- The ratio of slow-twitch to fast-twitch fibers is different in humans and chimpanzees. The predominance of fast-twitch fibers in chimpanzees is what makes them stronger.

98.8%

of a chimpanzee's DNA is shared with its closest relative: us. Both species descended from a common ancestor that lived between 7 and 8 million years ago.

PHOTOS: PR (3); Getty Images (2); DPA Picture-Alliance; anniepaddington/Getty; Karl Tapales/Getty; Teevit Lertchaturaporn/EyeEm/Getty; NASA.

12 UNNECESSARY WAYS TO DIE

Let's be clear: We start dying from the moment we're born. There's just no way around it—we all have to go eventually. However some of the things we do will get us to the grave far faster than others—and much faster than we would like. Here are 12 of the most surprising…

1 SITTING

The time that you spend as a couch potato can be relaxing—but it can also be fatal! That's especially true of office workers, who spend many hours per day sitting at a desk; commuting to work in a car or bus; in bars, cafés, and restaurants; and in front of the TV. It's the cumulative duration that makes sitting so hazardous: Sitting for long periods slows the body's ability to metabolize sugar and fat, which can lead to diabetes or cancer. A recent study found that prolonged sitting has even been associated with a higher risk of death: Sitting for more than three hours per day was responsible for almost 4% of all deaths in the 54 countries studied. The good news is that even a small reduction lessens mortality. The researchers found cutting sitting time to less than three hours per day increased life expectancy by more than two months, and even getting up every hour and moving around for a couple minutes can help.

2 STAYING UP LATE

Not much threatens our health more than not getting enough sleep. The National Highway Safety Administration estimates 72,000 crashes and up to 800 deaths per year are caused by drowsy drivers. And that figure is far lower than the estimate of the Centers for Disease Control and Prevention (CDC), which says 6,000 fatal crashes per year is more accurate. Major catastrophes, such as the *Exxon Valdez* oil tanker running aground and spilling millions of gallons of oil into the sea and the nuclear accident that took place at the Chernobyl Nuclear Power Plant have also been blamed on a lack of sleep on the part of the operators. Staying awake for too long creates stress within the human body, and chronic sleeplessness can lead to a variety of medical conditions, from diabetes and high blood pressure to heart attack or failure. Fatigue also causes the skin to age faster; it reduces libido, impairs memory, and can lead to depression as well as a weakened immune system and even contributes to obesity. In the case of weight gain, the body will attempt to compensate for its loss of energy during sleeplessness by increasing the appetite. And as if all that were not enough, chronic lack of sleep can even make you more likely to die: In the Whitehall II study of civil servants in the UK, researchers found that people who reduce their average sleep from the suggested minimum of seven hours per night to only five hours had a 1.7-fold increase in mortality risk, and deaths due to cardiovascular problems doubled. But too much sleep also raised the mortality risk: Those who slept more than eight hours were twice as likely to die. Lesson: Be moderate in all things.

WARNING!
WARNING!

3 TUBE TIME

Australian health researchers at the University of Queensland found every hour spent watching TV reduces the lifespan of the average adult by 21.8 minutes. People who watch TV for six hours each day “can expect to live 4.8 years less than a person who doesn’t watch TV at all.” A sedentary way of life has adverse effects that rival those of smoking, obesity, and a general lack of physical activity. Government guidelines: Get at least 150 minutes of moderately intense activity per week, ideally spread across the week.

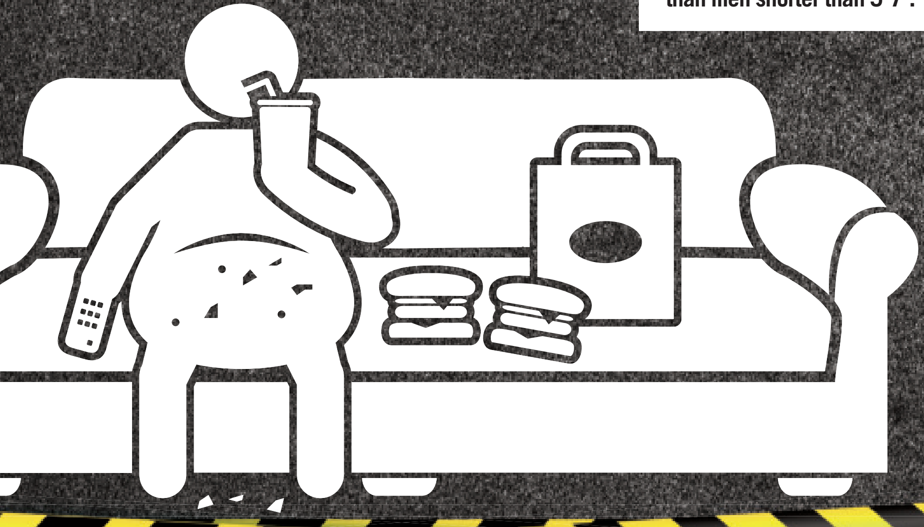
4 BEING SHORT

It may sound strange, but an Israeli study of more than 10,000 adult men revealed that the shortest in the group had a 54% higher risk of having a fatal stroke than the tallest. Each 2-inch decrease in height seemed to be associated with a 13% increase in fatal stroke risk. Why? According to the study authors, “A person’s height may be a strong indicator of nutritional status, especially in a study such as this, which included numerous subjects who had lived as persecuted minorities during childhood. It could be associated with environmental conditions in childhood and adolescence.”

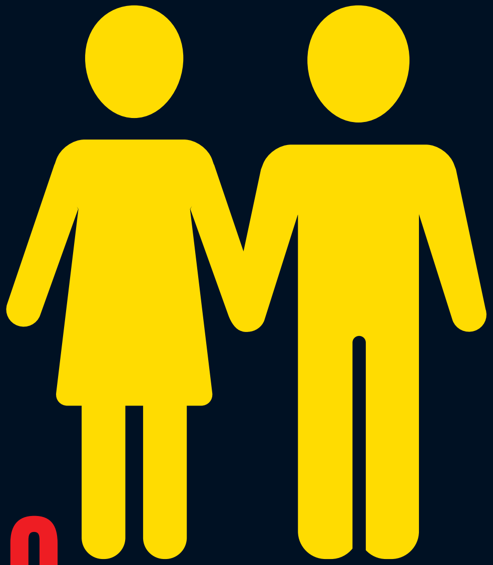
5 BEING TALL

There seems to be no escaping your height: A British study of 100,000 women found that for each 2-inch increase in height above the average of 5'3" the risk of ovarian cancer increased by 7%, and taller women had a greater risk of developing nine other types of cancer as well. So height appears to be an indicator of some cancer risk factor, however doctors admit they do not yet know what it is. But whether you’re short or tall, try to do the right thing: Avoid tobacco, maintain a balanced diet, be physically active, and get screening tests to detect cancer early, before it spreads. Another condition that seems linked to height: Alzheimer’s. One study found that men who were taller than 5'10" had an almost 60% lower risk of developing Alzheimer’s than men shorter than 5'7".

"WATCHING SIX HOURS OF TV PER DAY REDUCES LIFE EXPECTANCY BY 4.8 YEARS."



"AN AFFAIR CAN BE FATAL—BUT NOT BECAUSE OF JEALOUSY."



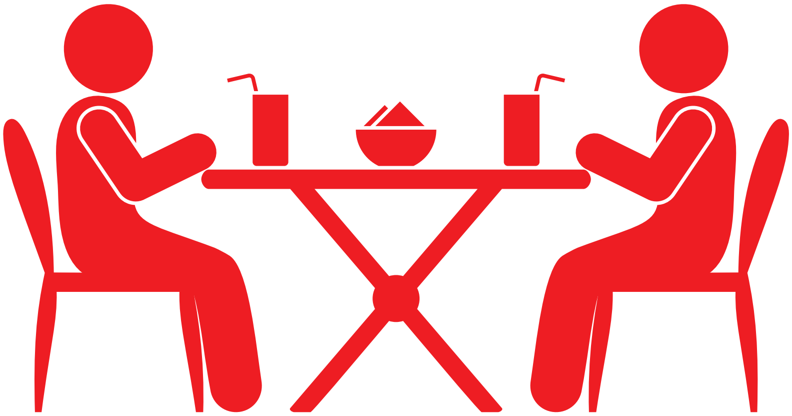
6 HAVING AN AFFAIR

We are all familiar with the cliché: An older man has a fling with a younger woman. Now cardiologists at the Cleveland Clinic have found that while it may be a cliché, it can also often be fatal. They reviewed autopsy reports of 5,559 cases of sudden death during intercourse. Men accounted for some 90% of the cases, and 75% of them were having extramarital sex at the time, generally with a younger partner. Sudden cardiac death during sex is rather rare, but when it does occur, extramarital sex is frequently involved. Lesson: Be careful about who you give your heart to!

CAUTION
CAUTION
CAUTION
CAUTION

7 EATING

In previous issues we have covered some of the foods that are bad for you. But here we're not concerned with fats, sugars, additives, and processing methods. In this case unnecessary death has a purely physical cause: choking. According to the National Safety Council, choking is one of the leading causes of death by unintentional injury. And the incidence is particularly high among the elderly and small children. In the former case, the risk is increased by living alone, wearing dentures, or having chronic difficulty with swallowing. In children, the humble hot dog is the biggest culprit. When a child gets a hot dog stuck in the throat, removing it can be extremely difficult. What should you do if someone is choking? First, encourage the person to cough forcefully. But if speaking or breathing is impossible, immediate help is needed. The best method is the Heimlich maneuver, which involves grasping the victim from behind, placing your fist against the abdomen just above the navel, and using the other hand to thrust inward and upward in short bursts. If the victim is unresponsive, CPR is the next step.



8 BEING HAPPY

Those who go through life with a smile enjoy life more. That may be true when it comes to happiness, but not for life expectancy. In 1921 Stanford psychologist Lewis Terman began studying 1,500 children with an IQ of 135 and above. Terman died in 1956, but today the results of his study show that those children who grew up to work the hardest also lived longest. The ones who were carefree and unambitious were largely unsuccessful and had a much higher mortality rate.

9 WEARING SUNSCREEN

Using sunscreen should extend life, not shorten it, right? After all, it protects against sunburn and thus also against skin cancer. But it can also contribute to a vitamin D deficiency. Not many foods are natural sources of vitamin D, which the body makes when ultraviolet (UV) light from the sun hits the skin. But people who live in northerly regions of the Northern Hemisphere may not get enough sunlight during winter. And while most people don't use enough sunscreen to block all the ultraviolet light, a troubling new study has linked a deficiency of the "sunshine vitamin" to increased mortality. Subjects with the lowest levels of vitamin D had a two-to-three-fold increase in risk of dying. Those with the highest levels showed a reduction in mortality of 30% to 40%. Use sunscreen anyway, but get 10 minutes of sun on unprotected skin three times per week for a dose of D.

10 DRINKING TOO MUCH

The topic here is not alcohol but water. A common recommendation is to drink eight 8-ounce glasses of water per day, which is reasonable and easy to remember. But our needs vary with gender, age, and activity level. The best guide is the color of your urine. Pale yellow is ideal; a darker color calls for drinking more water, and urine that is colorless suggests overhydration. In that case the primary concern is hyponatremia, a condition in which the levels of sodium become dangerously low, causing symptoms that range from mild to life-threatening.

11 CLEANING

In the United States nearly half of all fatal injuries occur in the home, resulting in around 6,000 deaths per year. A surprising number of them are related to the misuse of cleaning products, or more accurately, their combination. Bleach and ammonia are commonly found in American homes, and each is dangerous as a skin and eye irritant. But when mixed together they can create deadly chlorine gas. It's better to switch to natural cleaning products, such as vinegar. And if you feel the need to use a heavy-duty product to flush out your drains, for example, make sure to heed the warnings on the label and open a window. And of course: Keep all hazardous cleaning products out of the reach of children.

12 TAKING PAINKILLERS

Acetaminophen (Tylenol) is one of the most widely used pain relievers worldwide. It is available not only in pill or capsule form but also as an ingredient in numerous other medicines, such as cough syrups. While people sometimes believe that if a small dose is good, a big dose must be better, many people die each year from an acetaminophen overdose—or more precisely, of liver disease. Ingesting too much acetaminophen is the most common cause of acute liver failure: One very large dose or excessive amounts over several days is enough to cause the condition. Taking more than 7.5 grams per day (15 Extra Strength Tylenol pills) can be hazardous, and even just 4 to 5 grams per day has been reported to cause liver failure. One lesson to be drawn: Read labels. People sometimes overdose because they don't know that a combination product they're taking contains acetaminophen.

> "TAKING MORE ACETAMINOPHEN DOESN'T MAKE YOU HEALTHY FASTER—ON THE CONTRARY."

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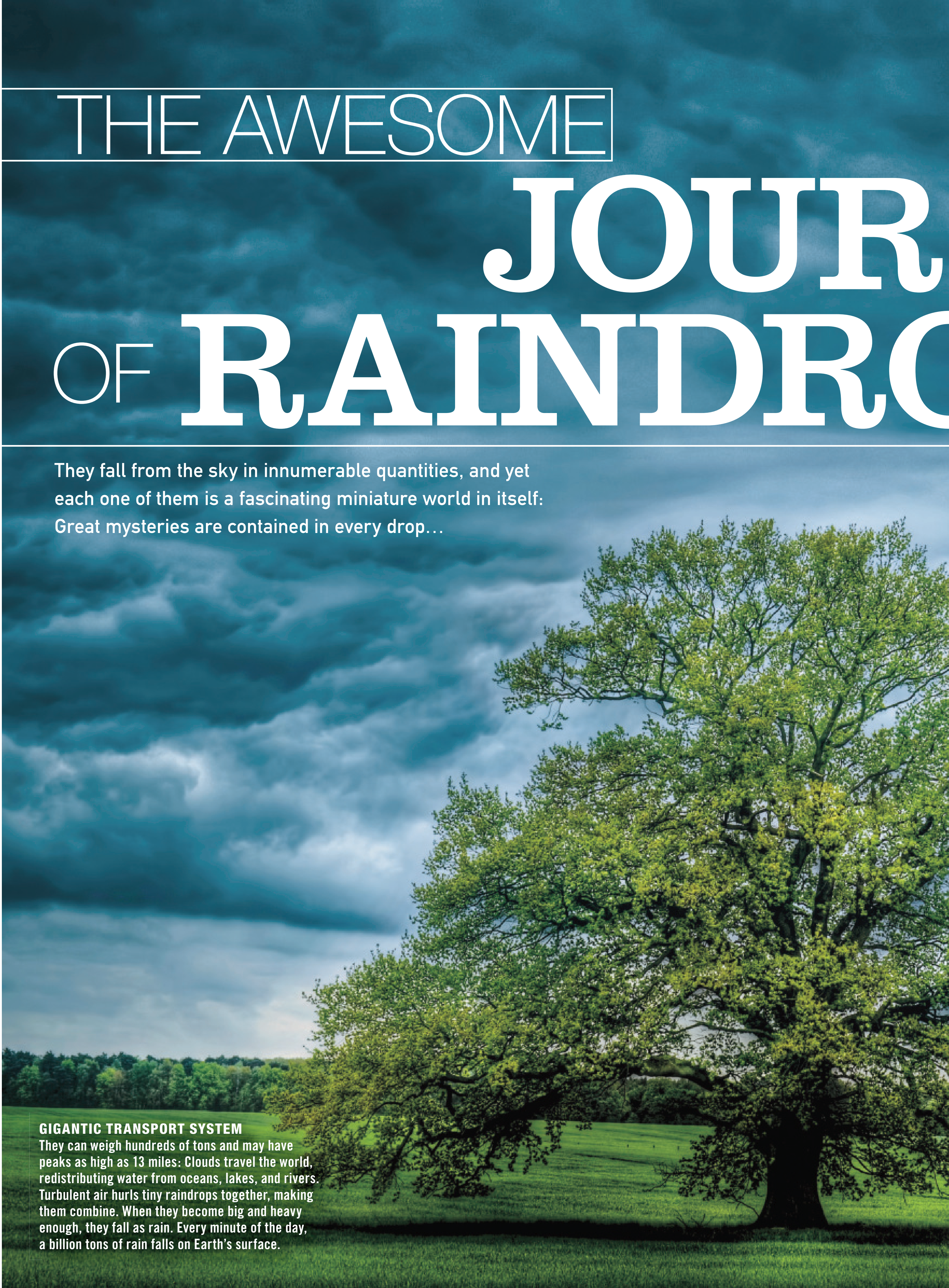
THE AWESOME
JOUR
OF RAINDRO

They fall from the sky in innumerable quantities, and yet each one of them is a fascinating miniature world in itself: Great mysteries are contained in every drop…



GIGANTIC TRANSPORT SYSTEM
They can weigh hundreds of tons and may have peaks as high as 13 miles: Clouds travel the world, redistributing water from oceans, lakes, and rivers. Turbulent air hurls tiny raindrops together, making them combine. When they become big and heavy enough, they fall as rain. Every minute of the day, a billion tons of rain falls on Earth's surface.

NEY OPS

HYDROPOWER
A raindrop can hit the surface of water at up to 20 mph—and still remain a drop. How does it do that? Water in raindrop form is more stable than the flat surface of pooled water.

The raindrop has already traveled for thousands of miles before it reaches the United States. Nine days earlier, its journey began as a water molecule over the Pacific when the energy of the Sun had lifted it from the ocean. Now it's rising higher and higher…

THE OCEAN ABOVE OUR HEADS

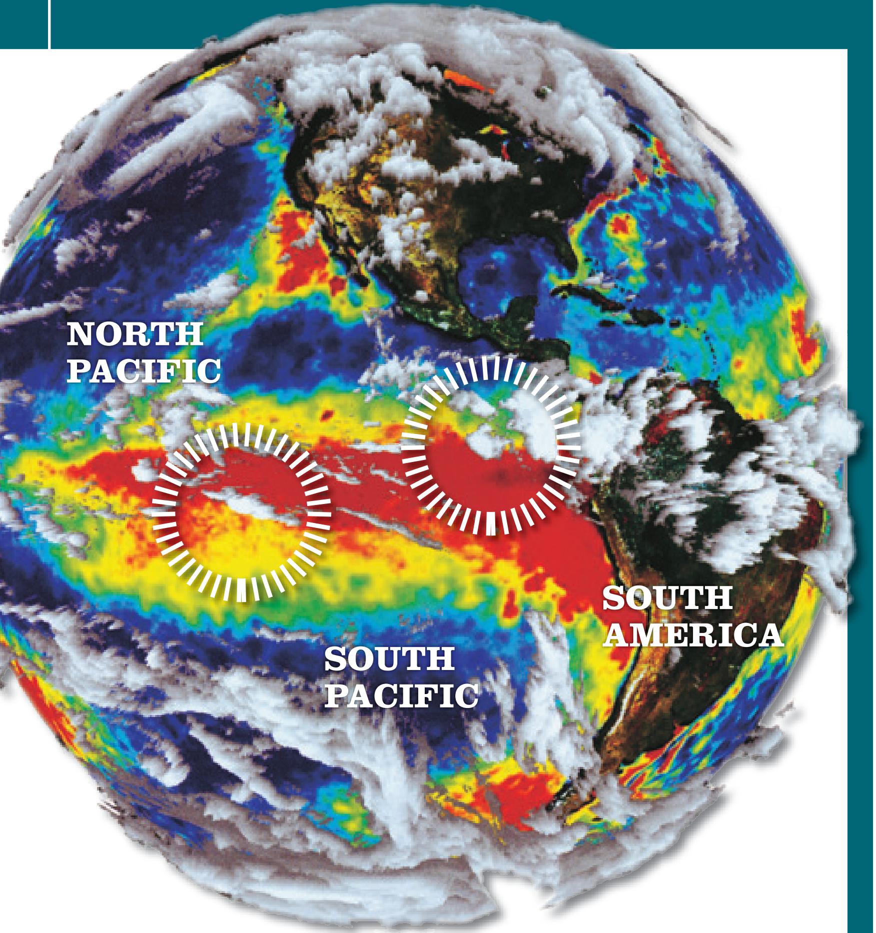
As the water droplets climb, the air gets colder and colder. Turbulence within the clouds causes the droplets to collide with one another and join forces, becoming ever larger. As the air temperature approaches 32°F, the water droplets form ice crystals that continue to collide and form larger particles of ice. When the ice particles become heavy enough, they fall, and if they melt on the way down, they hit the ground as rain. The final size of a water droplet or ice crystal depends on the amount of time it has spent in the clouds before falling. The longer it stays, the larger it becomes. That's why taller clouds produce larger water droplets, hailstones, or snowflakes.

According to the U.S. Geological Survey, there are about 3,100 cubic miles of water in the atmosphere at any given time. As big as that number may sound, it is only about 0.001% of the Earth's total volume of water. If it all rained down at once, it would cover the globe to a depth of slightly less than an inch. But instead, we get a warm summer rain shower here, a thunderstorm there, and perhaps a blizzard somewhere else. Unless you live in a very arid region, precipitation

>

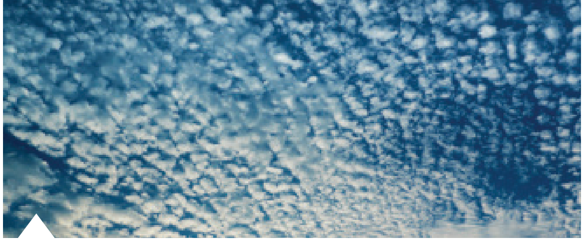
WE LIVE IN AN OCEAN OF MOIST AIR

Thanks to 3,100 cubic miles of water suspended in the atmosphere at any given time, clouds are one of nature's most dynamic phenomena. The power of the Sun lifts the water from oceans, lakes, and streams. But that alone would not be enough: Without the airborne particles of pollution called condensation nuclei (dust, sand, and salt particles along with living matter), there would be no clouds. Researchers have more recently discovered that around 85% of all raindrops contain microorganisms.

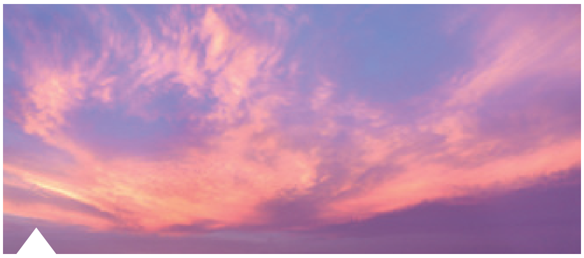


WHAT IS AN EL NIÑO?

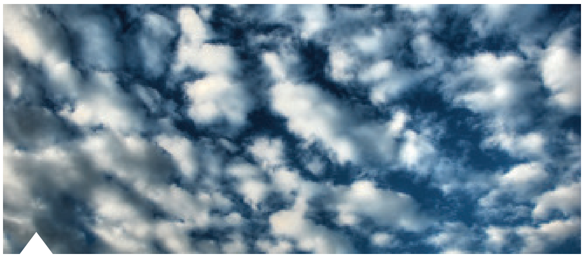
Since the Spanish conquest of Peru in 1525, chroniclers have documented a flow of unusually warm water (red area in the image above) along the west coast of South America around the Christmas season. Since the late 1970s, the effects of climate change have shifted the onset of this "El Niño" to the West Pacific and caused more frequent extreme weather events (circled areas indicate regions where more clouds are created and thus where bigger cyclones can take shape). Continued warming will make these events even more extreme in the future.



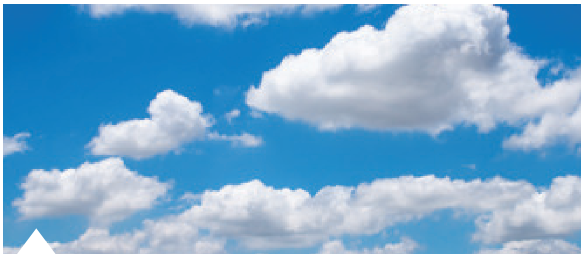
1. CIRROCUMULUS: Clouds that form small white rounded masses at a high altitude. The pattern of regular groupings is called a "mackerel sky."



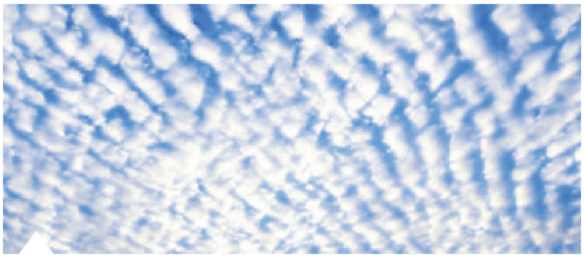
2. ALTOSTRATUS: Cloud formations that are similar to cirrostratus but darker and found at a lower level. They'll usually cover the sky.



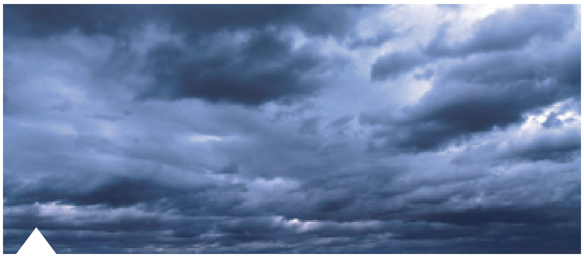
3. ALTOCUMULUS: Fleecy cloud formations consisting of large whitish globular cloudlets with shaded portions. They occur at mid-level altitudes.



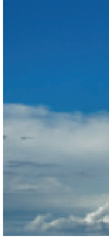
4. CUMULUS: Massed cloud forms with a flat base and rounded outlines; they are often piled high. The Latin word means heap or pile.

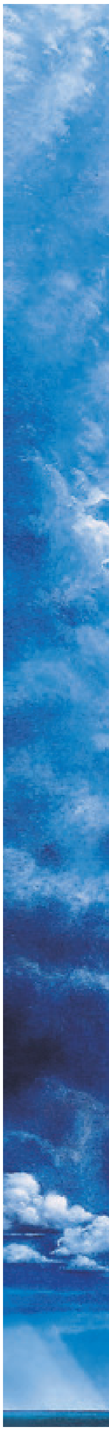


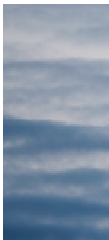
5. STRATOCUMULUS: Stratified cumulus clouds consisting of large balls or rolls of clouds; they often cover the whole sky, especially in winter.



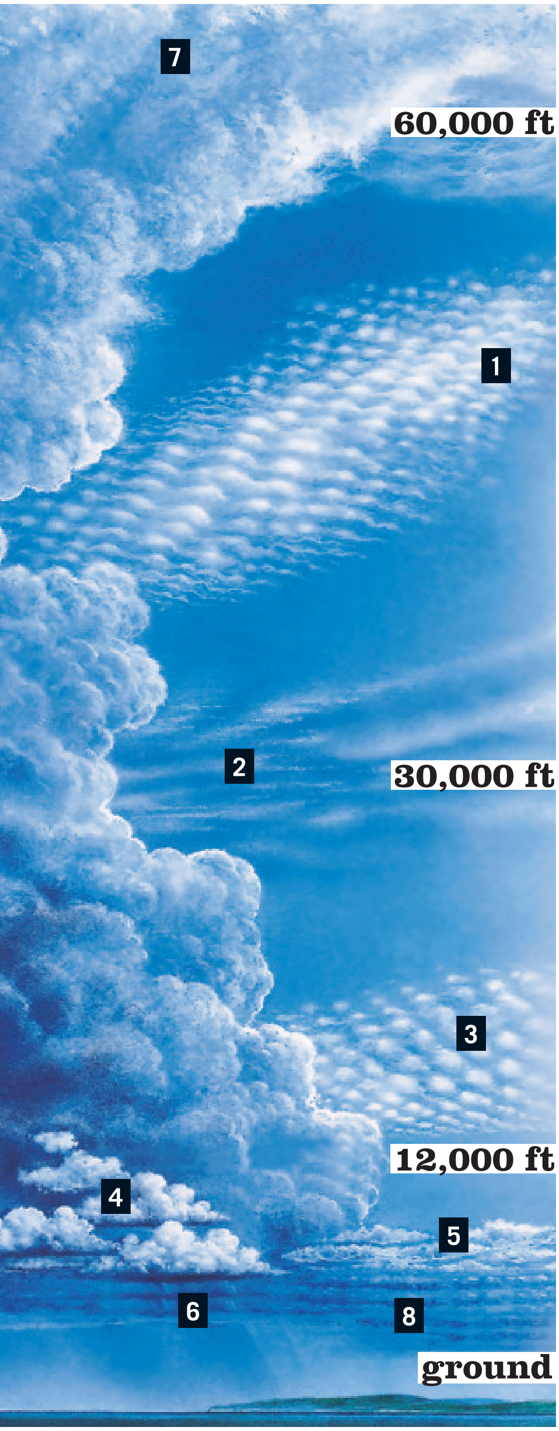
6. NIMBOSTRATUS: Low, dark-gray, featureless, and rainy clouds arranged in layers. They produce persistent rain and can block out the Sun.



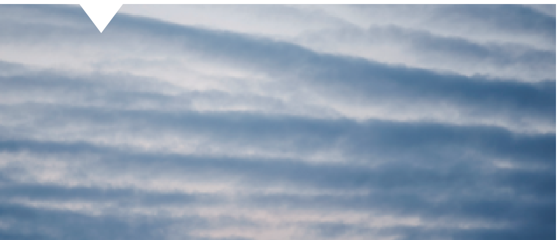


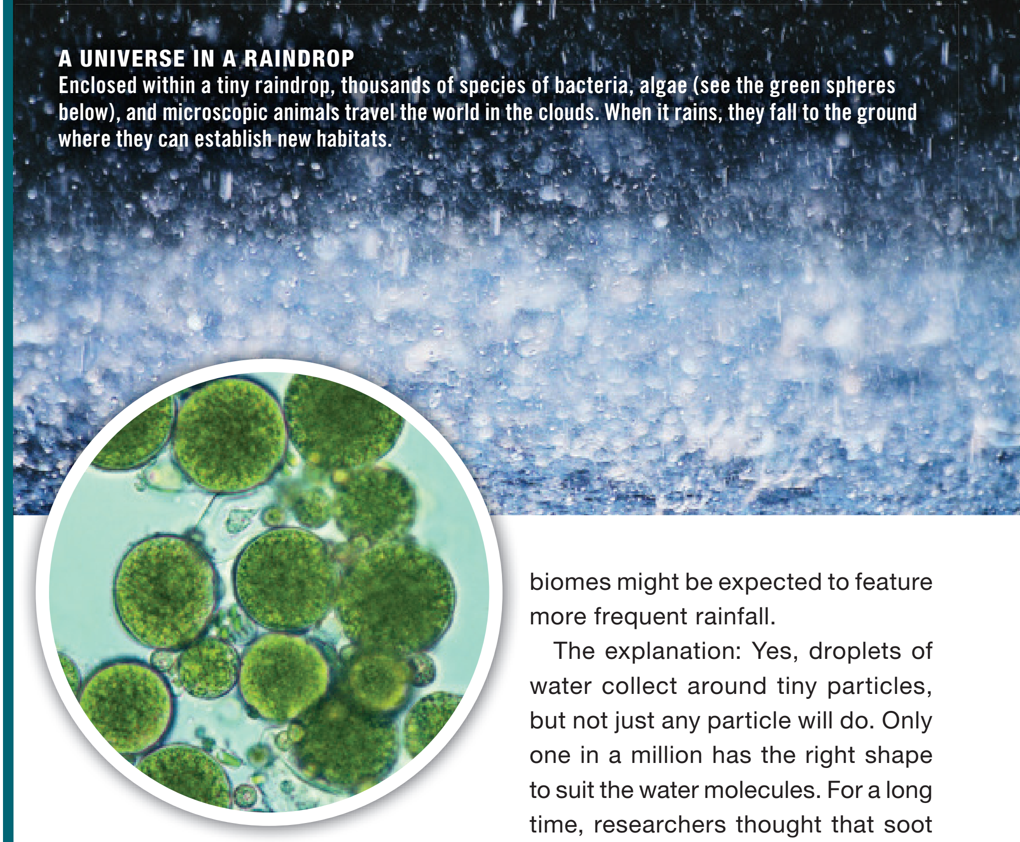


7. CUMULONIMBUS: A cumulus cloud that often extends upward to great heights. They're associated with thunderstorms and heavy rainfall.



8. STRATUS: Low-level clouds, usually between 2,000 and 7,000 feet. They have horizontal layers and a uniform base.





A UNIVERSE IN A RAINDROP
Enclosed within a tiny raindrop, thousands of species of bacteria, algae (see the green spheres below), and microscopic animals travel the world in the clouds. When it rains, they fall to the ground where they can establish new habitats.

is nothing special. But it keeps life on Earth alive: Without it there would be no plants or animals, and so humans could not exist either.

You may think nothing is purer than a raindrop. But the droplets of water form around small airborne particles of pollution known as condensation nuclei. In a natural environment these are mostly dust, desert sand, or salt particles from the sea. Increasingly, however, they're black carbon organic material generated by human activity: rubber from tires and soot from coal-fired plants and combustion engines. Recently scientists have discovered something much more exciting in the clouds: life itself. "The microbial life in the cloud droplets of a winter storm is amazing," enthuses University of Wyoming microbiologist Gary Franc. "There's an entire ecosystem inside the clouds that is largely undefined." Researchers believe millions of tons of bacteria may be finding their way into the atmosphere each year along with millions more tons of algae and fungal spores. But the combination of water vapor and seed particles does not necessarily result in precipitation. If it did, the coastal regions of desert biomes might be expected to feature more frequent rainfall.

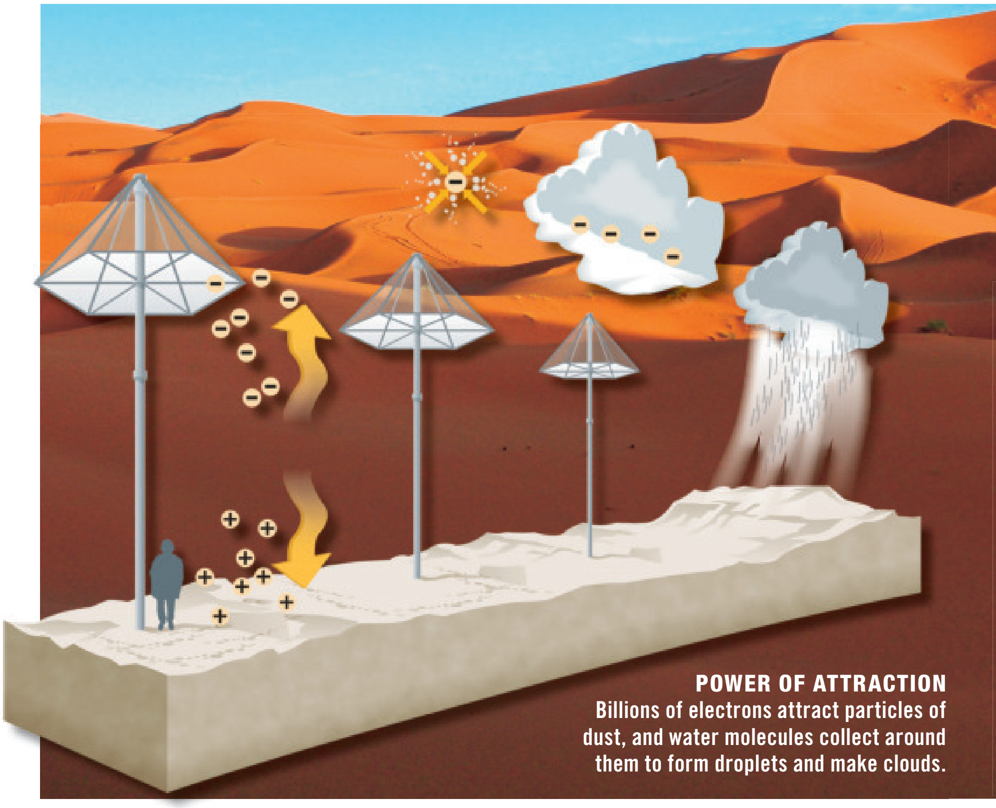
The explanation: Yes, droplets of water collect around tiny particles, but not just any particle will do. Only one in a million has the right shape to suit the water molecules. For a long time, researchers thought that soot and dust were more likely to supply that one-in-a-million chance for ice formation. The discovery of microbes in raindrops, however, has prompted some researchers to search for other answers. Some 10 years ago, a team led by microbiologist Brent Christner of Louisiana State University began cataloging rain-inducing microbes by studying fresh snow collected in North America, Europe, and Antarctica and found "rain-making" bacteria in every sample. While snow from Antarctica had fewer bacteria than snow coming from France or Montana, for example, even the Antarctic snow did contain bacteria. The researchers filtered the particles out of the melted snow and added them to pure water to see when it would freeze. They found that the larger the number of particles in the water, the higher the temperature at which freezing took place. "It showed that we had been ignoring some of the most active catalysts in clouds," says Christner. "Biological particles play a very critical role in generating snowfall and rain—especially at the relatively warm cloud temperatures."

NASA: THE CLOUD MAKERS
@ *http://bit.ly/makingclouds*

PHOTOS: Ulli Stein; A.Wilkens/Max Planck Institute for Dynamics and Self-Organization; NASA; PR; Apexphotos, Jeff Greenberg/Contributor, Sergio Amiti, Songsak Plodpao/EyeEm, Nancybelle Gonzaga Villarroya, assalve, orleijunior.com, John Lawson, Emelia Drewniak/EyeEm, Ed Reschke—all /Getty Images.

SMARTER IN **60 SECONDS**

Rain



POWER OF ATTRACTION
Billions of electrons attract particles of dust, and water molecules collect around them to form droplets and make clouds.

How do you **make it rain** in the **desert**?

They may look like steel palm trees, but the ionizers created by the Swiss company Meteo Systems International are designed to bring water to the Arabian Desert in the form of rainfall. The high-tech structures generate fields of negatively charged particles to stimulate cloud formation and have produced man-made rain in otherwise clear skies. During testing in Abu Dhabi, the ionizers were switched on 74 times over a four-month period on days when humidity was above 30%. They created rain on 52 occasions, even though the country's weather service didn't forecast rain or clouds. In some instances wind, hail, and lightning were created. The technology has other applications, but getting water to an arid region might be the most important one.

How much **energy** is there in a **drop of water**?

French researchers have found a way to extract electricity from falling raindrops. The amount of energy is dependent on the size of the drop, ranging from 2 microjoules per drop in a drizzle to 25 millijoules in a downpour. Jean-Jacques Chaillout and his colleagues at the Atomic Energy Commission used a piezoelectric transducer made of polyvinylidene fluoride, which vibrates to produce electricity. "We felt raindrops are an unexploited energy source," says Chaillout.

Where does it **rain the most**?

When it comes to copious amounts of rainfall, not even the lush rainforests of the Amazon can compete with Cherrapunji and Mawsynram, two villages in the northeastern corner of India. On average, Mawsynram receives 467 inches of rain each year, but Cherrapunji holds the world record, which was set in 1861: 1,042 inches in a single year. The wettest place in the U.S. is Mount Waialeale in Hawaii: At 460 inches, it comes close to being the rainiest spot on the planet.

When was the **Earth's first rain** recorded?

A storm that took place 2.7 billion years ago dropped rain on a fresh layer of volcanic ash in what is now South Africa. The craters it made were buried by more ash, and eventually the ashen mass became rock. When subsequent rains eroded the upper layers, those fossil raindrops were exposed. Researchers at the University of Washington have used them to determine their size relative to the raindrops of today. Their finding: Raindrops 2.7 billion years ago were about the same size, which indicates the atmospheric density was also similar.

Can a **rainbow** do a **headstand**?

When we think of rainbows, we tend to think of a convex semicircle with both ends touching the ground. But rainbows also exist in an upside-down form called a circumzenithal arc. Like a rainbow, this kind of halo is produced when sunlight is refracted by moisture, but in this case it is the moisture not of raindrops but of ice crystals, which are usually in cirrus and cirrostratus clouds. Such an arc is usually no bigger than a quarter of a circle, and because it looks like an upside-down rainbow, it has been called "a smile in the sky." Circumzenithal arcs are not rare, though many people overlook them because they tend to occur at high altitudes.

PHOTOS: Impact Photos/Sunday Times; Getty; AKG-Images/DPA/Picture Alliance; PR.

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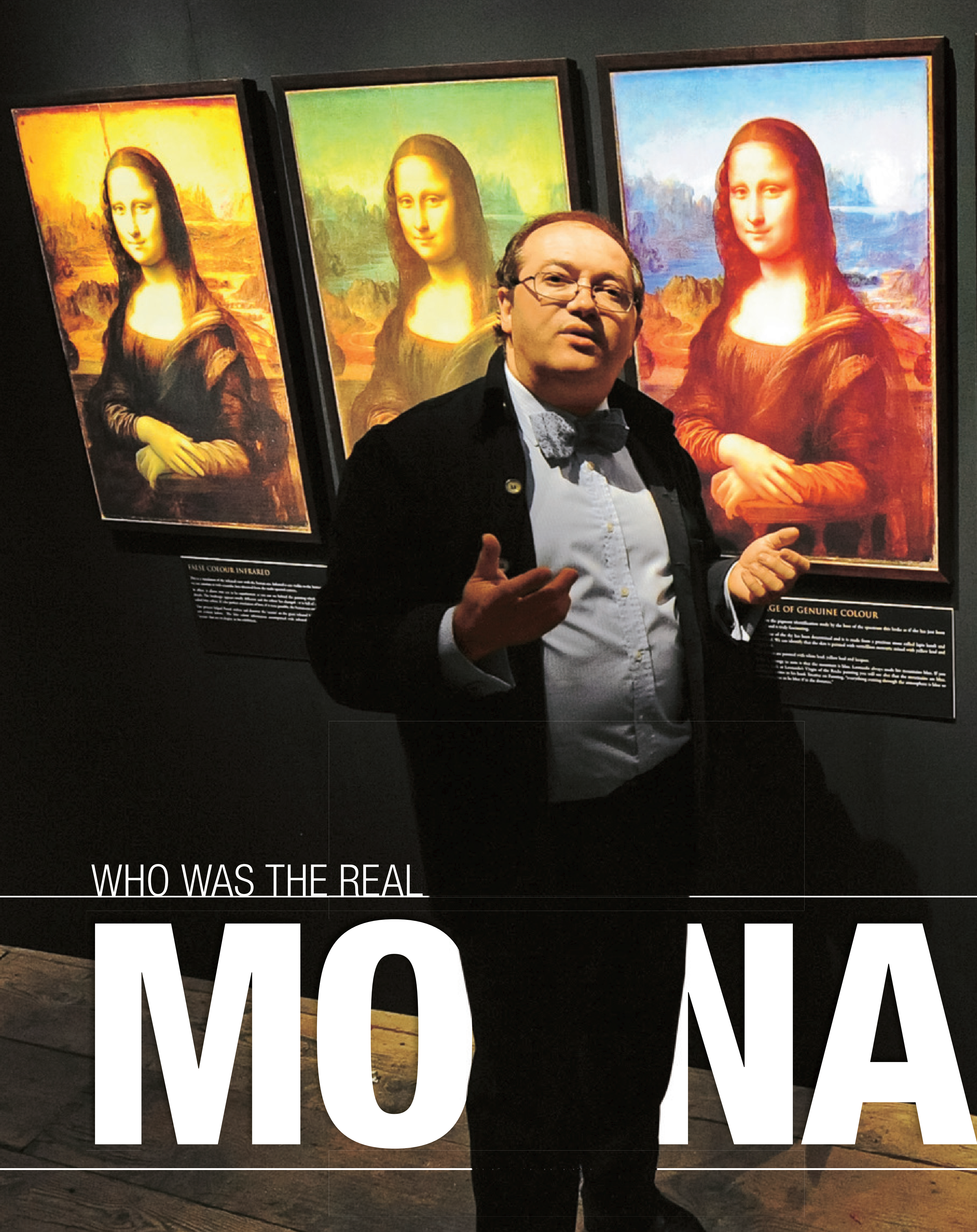
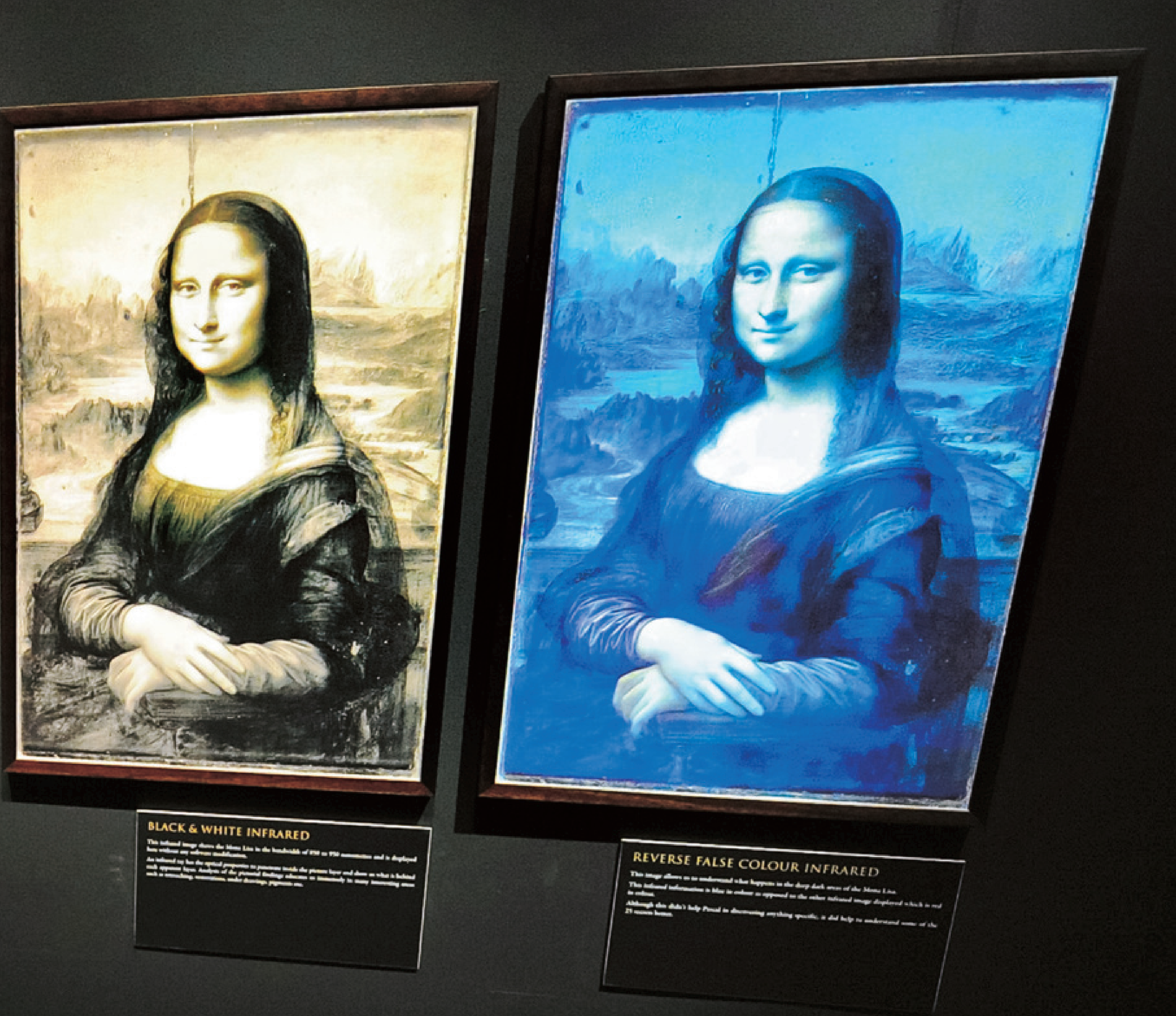

FALSE COLOUR INFRARED
GE OF GENUINE COLOUR

WHO WAS THE REAL
MONA


BLACK & WHITE INFRARED
REVERSE FALSE COLOUR INFRARED

For 500 years the art world has been puzzled by Leonardo da Vinci's *Mona Lisa*. But one of its mysteries could be on the verge of solution, the result of a French engineer's theory: Another masterpiece may be hiding behind the painting we see.

LISA?

Not too far from the mighty Château d'Amboise in the Loire Valley of France stands the smaller Château du Clos Lucé, which became the summer residence of the kings of France after 1490. Both châteaux made history in May of 1517, when a special guest arrived at the invitation of King Francis I. The visitor was a celebrated artist and scientist who had entered the service of the king half a year prior. His name: Leonardo da Vinci. Clos Lucé became his new home, and it was here that he died in 1519. The guest did not arrive with empty hands: In his luggage was a painting—his latest work, measuring a relatively portable 2'6" by 1'9". He called it “La Gioconda,” which means “the cheerful one” in Italian, but the work has since become world famous as the *Mona Lisa.*

HOW THE *MONA LISA* BECAME THE MOST FAMOUS PAINTING ON THE PLANET

Mona Lisa had enjoyed the company of monarchs long before she became the “queen of the Louvre.” From Clos Lucé the painting had entered the collection of the Sun King, Louis XIV, in the Louvre, the royal residence in Paris. When Napoleon Bonaparte became emperor after the French Revolution, he was fascinated by the portrait’s beauty and had it hung in his bedroom. When he was exiled to Saint Helena in 1815, the lovely lady returned to the Louvre collection. At first she did not attract huge crowds of visitors. It was not until 1858, when

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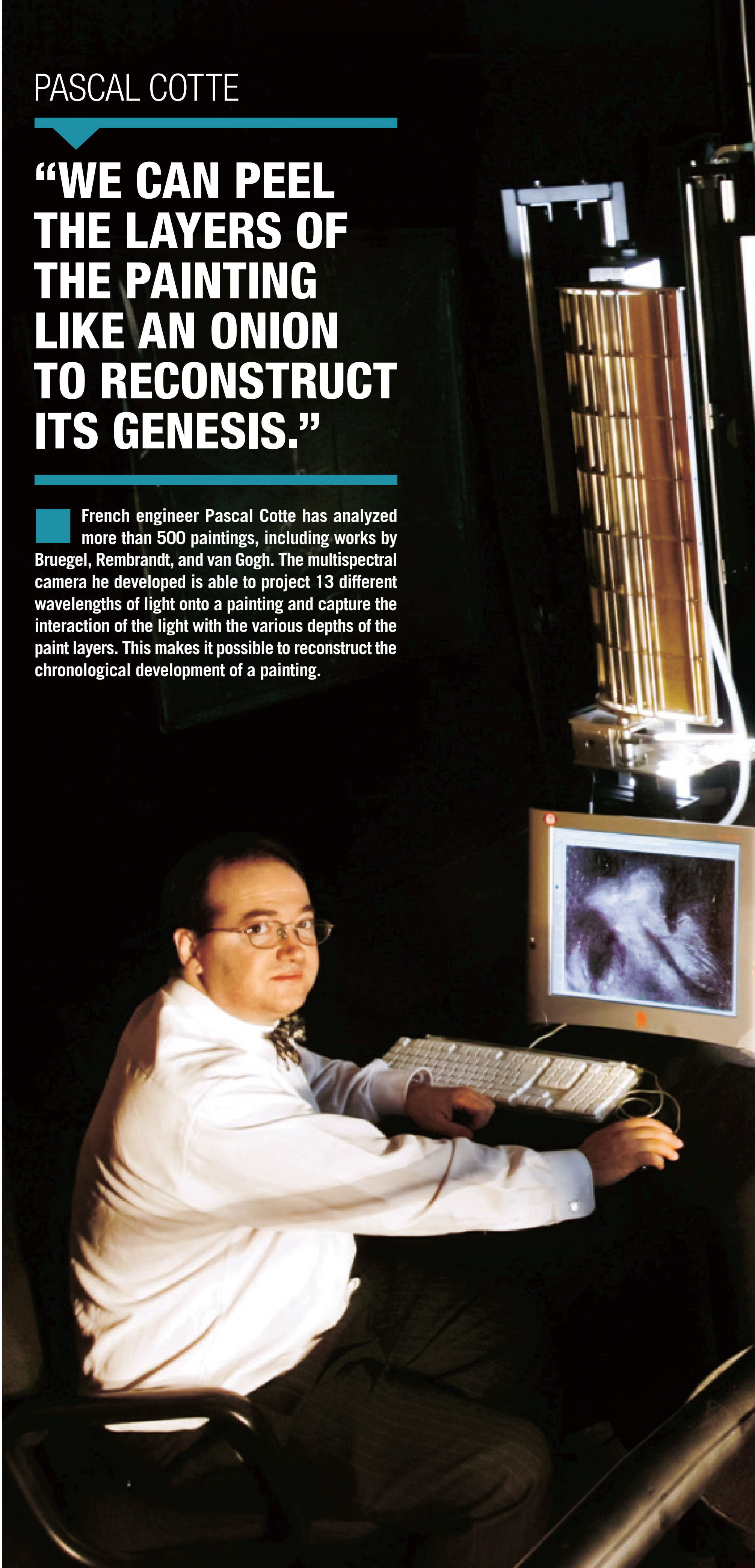


PASCAL COTTE

“WE CAN PEEL THE LAYERS OF THE PAINTING LIKE AN ONION TO RECONSTRUCT ITS GENESIS.”

French engineer Pascal Cotte has analyzed more than 500 paintings, including works by Bruegel, Rembrandt, and van Gogh. The multispectral camera he developed is able to project 13 different wavelengths of light onto a painting and capture the interaction of the light with the various depths of the paint layers. This makes it possible to reconstruct the chronological development of a painting.

influential art critic Théophile Gautier had written about her in the magazine *L'Artiste,* that she began to gain huge popularity as "the mysterious woman with the enigmatic smile"…

On the morning of August 21, 1911, three Italian handymen hurried out of the Louvre and ran across to the Quai d'Orsay railway station, where they boarded an express train out of town. It was not until 28 hours later that someone noticed the four bare hooks where the *Mona Lisa* was supposed to be. An army of police turned the museum upside down in their search for the missing masterpiece, but all they found was the empty frame and the case in an art supply closet where the robbers had hidden overnight.

Newspapers all around the world announced the theft in big headlines and it became a national scandal in France. All of a sudden the *Mona Lisa* had become a world-famous painting. The French flocked from around the country to see the empty spot on the wall where it had been. And it took a long time to find it: The ringleader of the art thieves, Vincenzo Peruggia, became so paranoid about being arrested that he hid the painting in a trunk at his Parisian boarding house for the next two years. But when he'd finally offered it to a dealer in Florence, the police were called in immediately to arrest him. He later claimed that he was just an Italian patriot trying to return the painting to the country to which it belonged. The Louvre got it back, and Peruggia got seven months in prison for the theft.

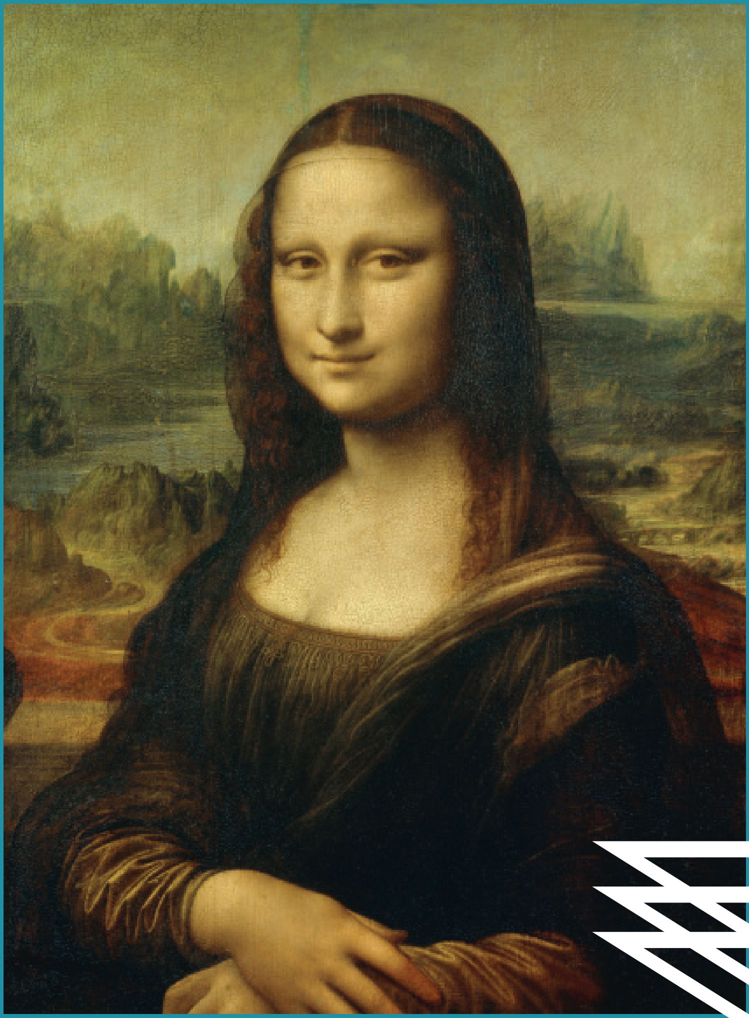
> **"IT IS QUITE SIMPLY ONE OF THE STORIES OF THE CENTURY."**
>
> **ANDREW GRAHAM-DIXON, ART HISTORIAN**

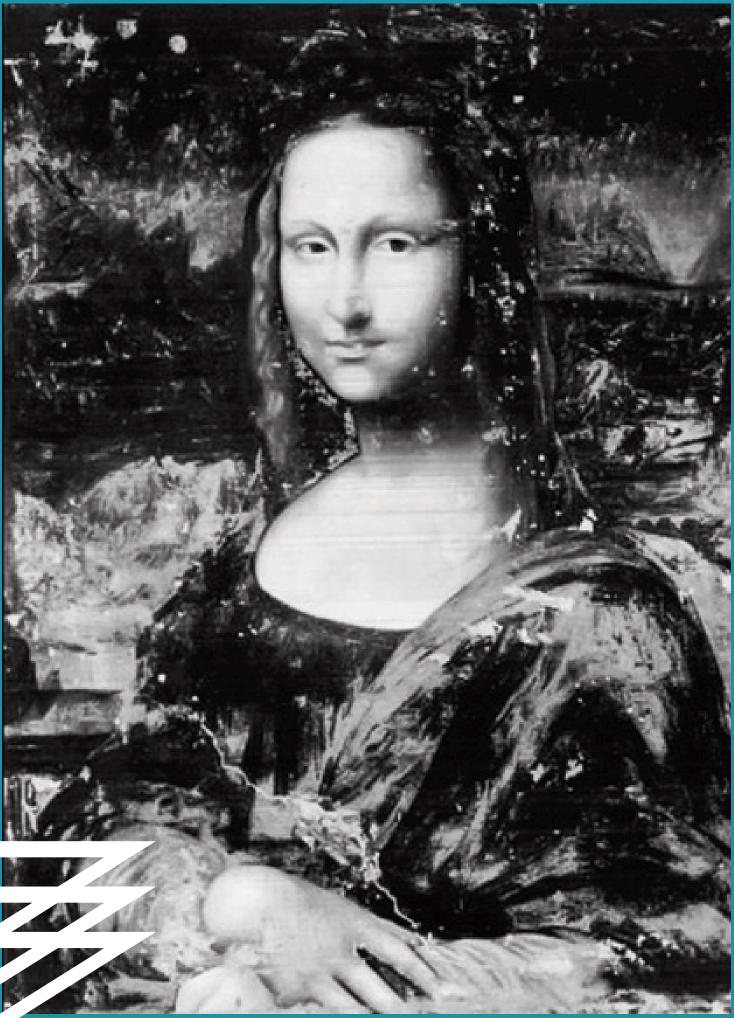
DOES ART HISTORY HAVE TO BE REWRITTEN?

Today the *Mona Lisa* is protected by a bulletproof glass case set behind a barrier, where she is seen by more than 10 million visitors every year. They view the same painting once so admired by Francis I, Louis XIV, and Napoleon, but are they really seeing everything? French engineer and art detective Pascal Cotte says they're not. Therefore with the permission of the Louvre he has examined the *Mona Lisa* with his innovative technology, a multispectral camera with a high resolution of 240 megapixels. (By way of comparison, a recently announced smartphone features the industry's first 108-MP sensor.) Cotte's camera records 13 different wavelengths of

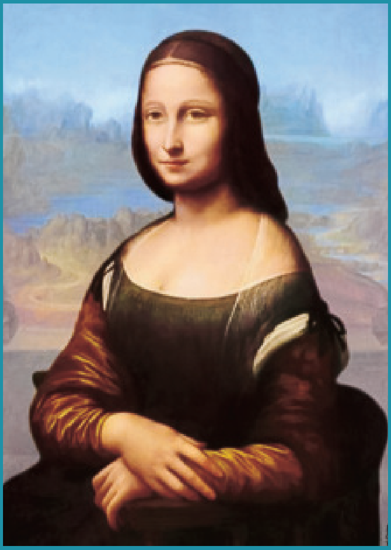
AN OLD PAINTING SEEN IN A NEW LIGHT

The Louvre permitted Pascal Cotte to examine the original *Mona Lisa* with his multispectral camera. The high-resolution images have been featured in special exhibitions, as seen here, for example, in Saint Petersburg.





reflected light, from ultraviolet to infrared, allowing him to peer behind the outer layer of paint that's visible to the eye. Artists in Leonardo's day seldom created a finished painting on blank canvas or unpainted wood (the support used for the *Mona Lisa*). Whenever they were dissatisfied, or wanted to save the money that a new support would cost, or were trying to hide something behind a new layer of paint, they would often paint over other finished or unfinished works. "We can now analyze exactly what is happening inside the layers of the paint," says Cotte. "We can peel all the layers of paint like an onion. We can reconstruct the chronology of the creation of the painting." In analyzing the 3 billion bits of data his process yielded, Cotte discovered the image of another woman under the surface of the *Mona Lisa*. Her head is turned by 14 degrees and it is much larger. Her mouth is also smaller and she has eyebrows, in contrast with the *Mona Lisa* we know today (compare the two images above side by side). And the camera revealed another important detail: Around the shoulders of the subject is a fine veil, a garment that in 16th-century Florence would only be worn by pregnant women. Was the real Mona Lisa pregnant? And who exactly is she? Traditionally she was known as Lisa Gherardini, wife of merchant Francesco del Giocondo. Art historians speculate Giocondo had commissioned this painting to celebrate the birth of his second son. But what are we really seeing in the painting that's hanging in the Louvre? An idealized portrait? Perhaps it's not Lisa at all, but Leonardo's mother, his lover, or even a self-portrait. One thing is certain: Pascal Cotte has revealed an earlier work by Leonardo da Vinci that no one had seen for 500 years.



WHICH IS THE REAL MONA LISA?

Pascal Cotte analyzed greatly enlarged photographic images and discovered 25 details that were previously unrecognized because they were invisible to the naked eye. A computer program has created a digital composite image (the small picture above) of the known *Mona Lisa* painting combined with the one underneath it.

PHOTOS: Getty Images (2); Christophel Fine Art/Contributor/Getty; Reuters; Pascal Cotte; PR.

What really counts in the end...

The orangutan in this photograph is more than 100 feet above the ground, at about the height of a 10-story building. And he's going to keep climbing, higher and higher, until he reaches the point where the branches can no longer support his weight. Why? Because that's what orangutans do. Now endangered by habitat loss (illegal logging and palm oil plantations), hunting, and the pet trade, orangutans prefer to live in a zone between earth and sky that is generally inaccessible to other creatures. That's where they're born, and that's where they spend most of the first six years of their lives with their mothers. Like their relatives, the chimpanzees and gorillas, orangutans have long arms and short legs, but their legs are disproportionately short and too weak to support their massive bodies. On the ground they use all four limbs to walk, resting the weight of the head and upper body on their clenched fists rather than walking on their knuckles as the other great apes do. Having thumbs and big toes that are opposable, they are also able to swing through the trees with ease.

For a long time zoologists thought the creatures were not particularly intelligent, but then Lithuanian-Canadian primatologist Biruté Galdikas observed them utilizing tools. Subsequent researchers found orangutans have invented what amounts to a “tool kit”

ALWAYS ON TOP OF THINGS

How we know orangutans are intelligent, with or without an IQ test…

that enables them to extract insects from tree hollows and harvest the seeds from hard fruit. These abilities vary among orangutan populations and seem to depend on their degree of cultural interaction with one another, being most evident in orangutans living in groups. Orangutans in Borneo were also found to have tools to help them communicate, using leaves to amplify the sounds they make. Fu Manchu, an orangutan at the Omaha Zoo, took things one step further. His keepers discovered that he could unlock the door of his cage to escape and release the other orangutans. It took a dental exam to find the tool he was using: Fu had been hiding a piece of wire in his mouth that he could bend into a hook and use to pick locks. Former zoo director Lee Simmons' conclusion: "Orangutans are the smartest animals." He found that the more intelligent ones got bored and sometimes destroyed things "just to have something to do." One orangutan made a makeshift crowbar to pry the tiles from the walls of his cage. Others have been observed untying complex knots to steal a canoe and travel around a lake, stacking boxes in order to climb and reach suspended food, and twisting straw into a rope that could be used as a swing. All this requires a high degree of intelligence, but testing an orangutan's IQ is a difficult matter. One Dutch television broadcaster attempted to compare an orangutan's intelligence with that of a prominent singing actress in 2007 and got surprising results: The orangutan scored 75 points, and the actress just 52. The lesson to be learned: Whether in animals or humans, intelligence can be hard to measure. And orangutans really don't have to prove anything to us anyway. They feel at home between earth and sky—in a realm where they don't need to make secret tools to regain their freedom.

PHOTO: Tim Laman/ Natural History Museum.

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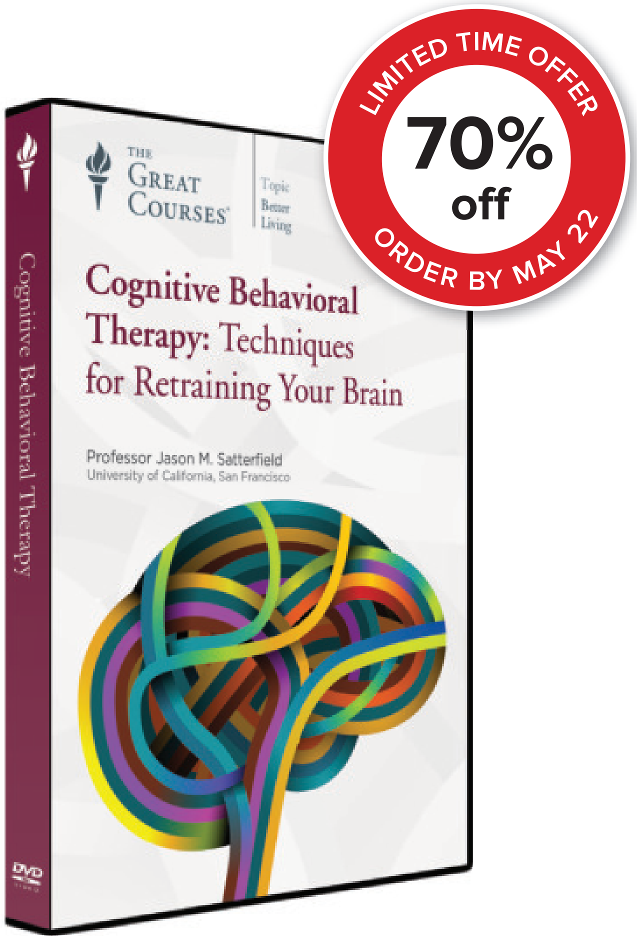
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